

A New Role of ubiHome: Harmonizing Residents at Home

Choonsung Shin^{*}, Seije Jang^{**}, Woontack Woo^{*}, Sang-Goog Lee^{***}

ABSTRACT

With the advances in ubiComp-enabling technologies, there has been a rapid increase in interest towards a ubiHome that can provide users with context-aware services in a home environments where people spend most of their time. However, there are obstacles in realizing ubiHome for daily life because the role of ubiHome is still ambiguous to residents. In this paper, we highlight a novel role of ubiComp technologies for the home: to harmonize family members, who share service resources in a space, by providing them with interactive methods for negotiating conflict situations. Our finding from user studies provides a guideline for avoiding conflicts among residents by listing when the conflict can occur, and how to handle such a potential conflict situation. As a result, harmonious home can play an important role in increasing time when family members stay a space altogether for their services.

요약

유비쿼터스 관련 기술이 발전함에 따라 가정환경에서의 상황인지 제공이 가능한 유비쿼터스홈 서비스에 대한 요구와 기대가 빠르게 급증하고 있으나, 그 역할 모델(개념)에 대한 모호성으로 인하여 유비쿼터스홈 서비스에 대한 실현이 어려움을 겪고 있다. 본 논문에서는 같은 공간 내에서 서비스 충돌상황 해결을 위한 상호협의 방법을 제공함으로써 서비스 자원을 공유하려는 가족 구성원간의 협력에 대한 새로운 역할 모델을 정립하였으며, 사용자 및 사용성 평가를 통하여 사용자 간의 충돌이 일어나는 때와 잠재 충돌상황 처리방법을 점검함으로써 충돌을 피할 수 있는 가이드라인을 규정하였다. 결과적으로 유비쿼터스홈은 가족 구성원이 함께 거주 할 때의 서비스 활용 시간을 증대하는 중요한 역할을 수행할 수 있었다.

Keyword

Ubiquitous Computing, Service-conflict Resolution, User-centric, Transparent and Harmonious Service Context

* 광주과학기술원 정보통신공학과

** 삼성전자 기술총괄 Digital Solution 센터

*** 가톨릭대학교 멀티미디어시스템공학과

접수일자: 2007년 12월 11일

I. Introduction

Recently, ubiquitous computing (ubiComp) has been a hot issue in the area of information technology. The term 'ubiquitous' is not strange to people anymore because it often appears in various media, e.g. news, advertisements, movies, and so on. In ubiComp environments, computing resources could be omnipresent in daily life, and connected seamlessly with each other in order to provide information or services anywhere at any time [1].

Such ubiComp-enabling technologies will bring a lot of changes to our life at home. Home is the most important environment where people spend more time to relax themselves than in any other place. Generally, residents expect to get simple, easy, and convenient services, as much as possible that adapt to the individual's situations. However, most residents still hesitate to exploit new technologies in home because they are annoyed or afraid of learning unfamiliar technologies even if the technologies guarantee better conveniences. In this respect, ubiComp-enabling technology will play an important role for the mainstream penetration of ubiHome into our daily life since it hides the complexity of the technology from residents, and provides simpler interactions.

In fact, much research, on ubiquitous computing, has concentrated on supporting residents in "ubiHome", a home environment where the concept of ubiquitous computing is embodied for example, in a room where music automatically plays and adapts to the people within, pictures in the frames on a desk can change depending on which person is working there [2]. In-house context-aware communication systems allow family members to speak to each other as if they were in the same room, even when they are not [3, 4]. Support for the elderly or the provision of emergency services, such as fire, burglar, or injury, is a requirement of daily life [5, 6].

Although some ubiHome scenarios attract people's interest, there is a problem that ubiHome services have been focused on one resident. This may cause conflicts among residents who simultaneously stay at the same service space since each resident is automatically provided with personalized service according to each individual resident's context [7]. Conflict is a situation where some residents are not provided with their preferred services due to two main causes [8]. One cause is the collision of system resources since more than one resident or application accesses the same resources simultaneously. The other is the discord of resident's mental state since a resident cannot withstand some exclusive services, e.g. watching TV vs. listening to music, watching TV vs. reading newspaper, and so on. When a conflict rises, the personalization for one resident often makes others give up their services or move to another location. For example, when a resident watches a world cup final game in a living room,

the other who wants to watch a TV drama cannot help moving into another room, e.g. a bed room, where another TV is installed. Improper conflict resolution causes residents to seriously argue with each other, and to separate from other residents for personalized services.

Many related works have reported that proper conflict resolution plays an important role in harmonious environments. At home, conflicts among media services or appliances had been addressed [7, 10]. In addition, the methods handling conflicts have been suggested such as assigning service resources to each users, selecting the high-priority user or service, recommending service lists, and mediating users [10, 11, 12]. Although providing available methods to resolve conflicts among services or residents, these works do not effectively protect occurrence of conflict situations from our daily life. We believe that the most effective way for handling conflicts is to avoid conflict situations beforehand.

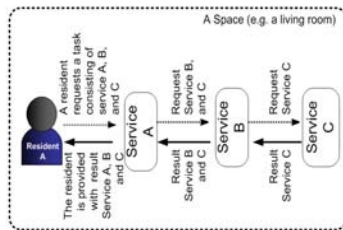
For avoiding conflicts situation among residents who frequently share service resources in a space, our approach is to investigate when residents collide with each other on service, and how residents are provided with interactive methods for handling conflicts. As a result of our user studies, conflict situations often occur in case where a resident enters [leaves] a space in which more than one resident is present, and a new service starts or the inhabited service that is already triggered and shared by residents in a space, finishes. Therefore, it will reduce conflicts for some proper conflict-handling processes to be provided whenever those activities of residents occur. In addition, by investigating residents' disobedience on result of several-conflict-handling methods, we reconfirm that it is important that residents participate themselves in a conflict-resolving process by negotiation with others as conflict-handling processes [12]. This simplifies residents-conflict-resolving problem by providing guidelines about when the conflicts appear and how to handle the conflict. This can be one of important factors for implementing harmonious home environment that enables to increase time of residents' staying together for their services.

This paper is organized as follows: In Section 2, we describe the concept of a harmonious home by focusing on handling conflicts among residents. Then, when a conflict occurs and how to handle the conflict from end-users' view points are explained in Section 3 and 4, respectively. Finally, conclusion and future work are discussed in Section 5.

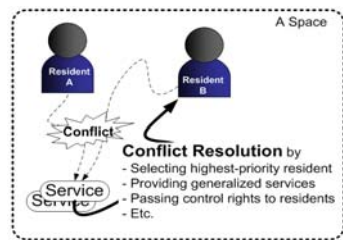
II. What is A Harmonious Home ?

In general, harmonious home may have two kinds of meaning: one is to manage service

resources efficiently for satisfying requirements of each resident the other is to resolve conflicts among residents who stay in the same space. The former is about service collaboration where a service collaborates with other services for satisfying a resident's requests as much as possible. The service to be triggered by a resident mutually influences other services. In order to watch a movie, for example, a resident controls a light, adjusts a couch, and turns off a radio or mobile phone. From this point of view, harmonious home providing a resident with a service is to trigger the resident-requested-service as well as the related services according to the resident-centric situation. To achieve this, after recognizing resident's implicit requests from context, a service should have the ability to invoke other services, or to exploit the results of other services, as shown in Figure 1(a). The latter is about conflict resolution which is a way to manage conflicts on providing several residents with each individual service. When residents stay in the same space, e.g. a living room, it often occurs for the residents to simultaneously access the same service or the collided services. While a married couple watches a TV at a living room, for example, the husband wants a sport channel but the wife wants to watch a drama series. Or, the husband wants to listen to music, but the wife wants to clean a living room with a vacuum. For managing such a conflict, residents require harmonious home to resolve the conflict, as shown in Figure 1(b).



(a)

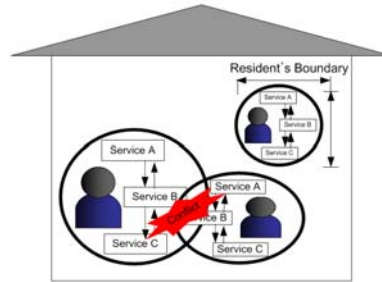


(b)

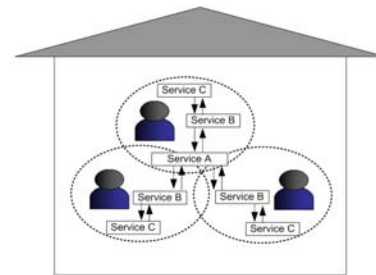
그림 1. 가정환경을 위한 조화 개념
(a)협력서비스 (b)충돌해결

Fig.1 Concept of Harmonization for Home Environment (a) Service Collaboration (b) Conflict Resolution

Although service collaboration plays an important role in harmonizing home environment, service collaboration biased ubiHome may fuel separation of residents' relationship. The more context-aware and proactive computing are advanced, the more service collaboration will expand the resident's boundary for occupying space or service. The boundary represents a working era of resident's services. A overlapping of the boundary among residents means that a conflict may occur, as shown in Figure 2(a). With the advance of mobile computing technologies, the increase of each resident's boundary often causes conflicts among residents. If there is no way to resolve conflicts among resident's boundaries, residents will not stay in the same space to spend time together because they are accustomed to personalized service environments. They feel uncomfortable to share a space or a service with even family members. For example, it is not easy for all family members to watch a TV altogether in these days even while staying at home. Since TVs are installed in more than one room, they need not to share a space for a TV. The extreme case of such separation is the life style of plant 'Solaria' in a novel 'Robot' by Isaac Asimov. In that sense, the service collaboration is an essential factor of harmonious home for one resident, but it is not enough for harmonious home where more than one residents share a space together.



(a)



(b)

그림 2. 유비홈의 두 가지 유형
(a)거주-분리 가정 (b)거주-조화 가정

Fig.2 Two types of ubiHome (a) Resident-separated Home (b) Resident-harmonized Home

Conflict resolution is one of the most important issues of harmonious home where more than one residents share a space together that manages each resident's boundary as well as personalized service. Conflict-resolution heavily affects the resident's life style at home because it decides which service is provided and where residents get service. When a conflict arises among a married couple on watching TV, for example, if a conflict-resolving method assigns each one to a TV located in different rooms, they may watch TV separately. Considering that separation may repeat daily, it is natural for the couple to occupy different room for a TV even if a conflict does not occur.

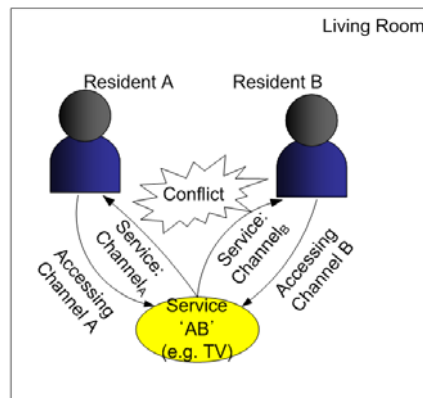
On the other hand, assuming that the couple gets TV service at the living room together due to a conflict-resolution method that differently solves the above conflict, it provides residents with more chances to negotiate the conflict by exchanging individual opinions, and interests, as shown in Figure 2(b). As a result, they may watch TV and spend time together by sharing a space or a service. From this point of view, conflict resolution plays an important role in keeping a harmonious relationship among residents of ubiHome.

For designing a harmonious home, it is necessary to approach the conflict-resolving issue from end-user's view points. This approach provides a novel vision for avoiding conflict among residents that is too abstract and difficult to solve it from system or resource level views. The end-user's view provides hints for managing conflict situation, detecting when conflicts among residents occur, and deciding how conflicts are to be resolved.

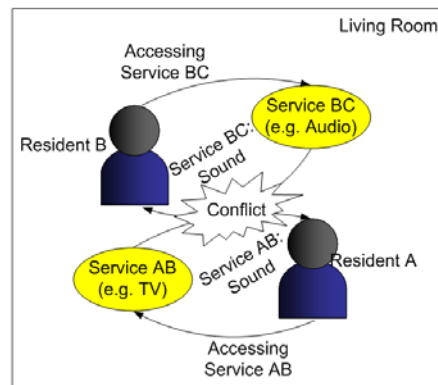
III. When Does Home Become Disharmonious?

Unlike an office or classroom, services at home are dynamically-changeable tasks and ambiguous with regard to starting, pausing, and stopping. This is because home is a place that enables residents to exploit a service without a sense of particular purpose, to access several services at a time, and to switch between them again and again. Such a chaos often causes home to be disharmonious. For example, residents frequently argue over watching TV program. A resident listening to music with an mp3 player cannot help stopping it after moving from her room to living room due to interruptions, e.g. noise, inhabited services, etc. in the new space. As a result, even if there is not any conflict, the residents have a seat for separated TV in a living room or bed room, or a resident is completely separated from other residents by listing music loudly through personal device.

Conflict at home is a situation where several residents try to access the same service or discordant services, e.g. radio and TV, which are simultaneously triggered, as shown in Figure 3. Conflict enforces selection of one among collided services, so that it causes some residents not to be provided their preferred service in case that they lose the service competition. Especially, conflict is serious in ubiHomes that automatically provide a resident with personalized service according to each individual resident's context. The services are usually focused on one resident at a time and automatically triggered if a certain condition is met. Therefore, it is possible for discordant services to be triggered concurrently when more than one resident stay at the same service environment zone.



(a)



(b)

그림 3. 가정에서의 충돌

(a) 거주자 간의 충돌 (b) 서비스 간의 충돌

Fig.3 Conflicts at Home (a) A conflict between residents (b) A conflict between services.

To investigate such a disharmony occurrence at home, we first observed when such a conflict occurs in a ubiHome environment. To check the number of resident's argument on services, we conducted 3-hours usability test with 8 triple-resident groups (4 families, 4 friends) with ages ranging from 9 to 51. All participants were required to count the number of argument in questionnaire sheet describing several conflict situations when they felt the need to manipulate services during staying in the living room. Our goal for this investigation was to determine when conflicts among residents occur. Each group consisting 3 residents were provided with TV and music service in ubiHome installed in our university [8]. We collected a total of 59 argument counts from our subject groups.

표 1. 서비스 환경 변화에 따른 거주자 충돌 횟수

Table 1: The number of resident's conflict depending on changes of service environments.

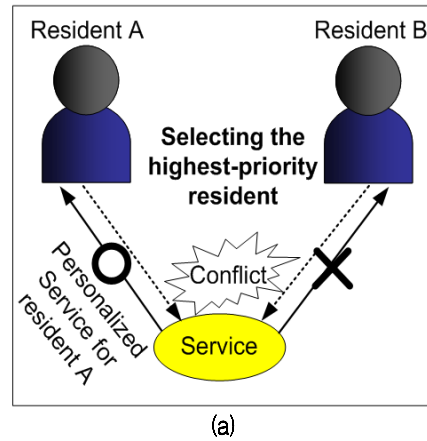
Description of event categories when conflict occurs	# of Count
When a new resident enters to a living room	19
After a resident leaves from a living room	11
During three resident stay together	5
When a new service triggers	8
After a triggered service pauses or stops	14
During there is no change among services	2

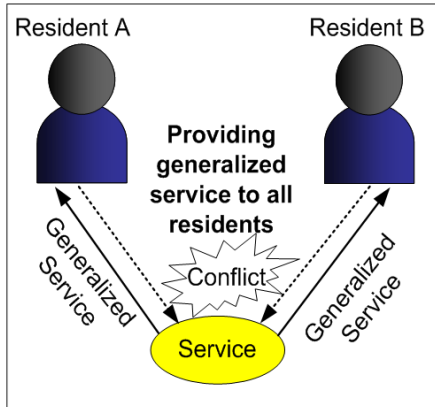
According to Table 1, the number of residents' argument on services at ubiHome heavily has arisen in case where a resident enters [leaves] a space in which more than one resident occupies, and a new service starts or the inhabited service is completed. This is because residents consider it as a service-turn-around time when a change of inhabited residents and services occurs. That is, they feel free to state their opinions to modify service environment after changing inhabited residents or services. On the other hand, most residents won't interrupt the inhabited services without such a change.

Our finding from this study guides when home environment can take actions for avoiding conflicts by monitoring simple status of residents and services in a space. Providing some methods for handling conflicts when a resident comes in or a triggered service finishes, home enables residents to avoid conflict situations beforehand. This helps home to avoid conflicts without any complex situation-aware processing. Based on above results, in the next section, we describe how to handle conflict among residents.

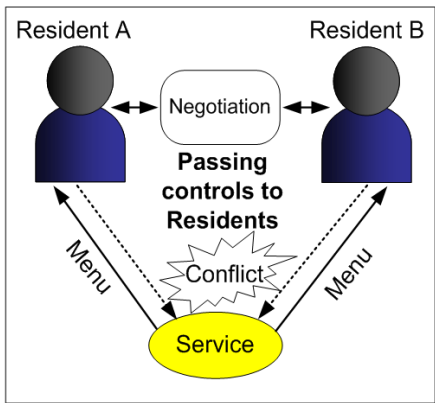
IV. How to handle a Potential Conflict Situation among Residents at Home?

To handle conflicts among residents, in general, there are two categories: automatic resolving and manual one. The automatic resolving is a way that enables an environment to avoid a potential conflict situation through selecting one of the collided residents or services by means of context such as users' preferences, location, time, and priorities among residents or services. For example, a priority-based resolution [7] gives priority to the highest-priority residents to get service, while lower-priority residents are prevented from accessing services if a conflict among residents occurs, as shown in Figure 4(a). In addition, a group-context-based resolution [9] enables a service to react on a group representing the average preferences of all residents, while some of them can be provided with the averaged service that is far from their original request, as shown in Figure 4(b). On the other hand, the manual resolution [10] is a way that lets residents to handle a potential conflict situation by providing conflict-status information. For example, a menu-based resolving way provides residents with a conflict-situation menu including each resident's preferences or recommendations, so that they could negotiate who gets service or which service is triggered, as shown in Figure 4(c).





(b)



(c)

그림 4. 잠재된 충돌상황 취급 예

(a) 잠재 사용자 중 우선권이 가장 높은 사용자의 선택
 (b) 모든 잠재 사용자의 요청사항을 통합하여 일반화된 서비스 제공
 (c) 사용자로부터 하여금 충돌 상황을 수동으로 중재하게 하는 예정보표를 건네주기

Fig.4 Examples of handling a potential conflict situation

- (a) Selecting the user who has the highest priority among potential users
- (b) Providing generalized service to all potential users by merging their requests
- (c) Passing a menu which allow users to manually mediate the conflicted situation.

In home environment, automatic resolution is still far from acceptance by residents. In daily life, conflict handling ways, e.g. rock-paper-scissors, argument, fight, etc. are interactive processes among residents. Furthermore, a result of residents-resolved conflict heavily depends on abstract situations, e.g. their social relationships, individual intention or emotion, etc. It is difficult for automatic resolution to make a right decision every time by being aware of high-level interactive situations among residents. Even after resolving a conflict by the automatic way,

residents may disobey if they cannot catch a reason how to handle the potential conflict situation.

On the other hand, manual resolution is more practical for usage in daily life. The manual resolution way provides plentiful information about a potential conflict situation and hands over controls to residents for handling the conflict. It makes residents believe that they are completely controlling the home environment, and that they fairly accept the conflict-resolved situation. This is because resident participate themselves in interaction through home technology, and they accept the result of their participation.

To check the number of disobedience on conflict-handled results, we conducted usability test with the same subjects in Table 1. All participants were required to count the number of manipulation of service as soon as a potential conflict situation was resolved after resident's entering, and inhabited service's stopping. Half of 8 triple-resident groups (2 families, 2 friends) were provided a service which was automatically chosen by a priority-based resolving way. The other half were provided with a menu through a TV that displayed conflict-status on services, such as TV service: the preferred channel information, and music service: the favorite music lists. In case of priority-based resolution, default priority is assigned to each resident. The priority of each resident is dynamically changed according to the counter residents, e.g. between husband vs. wife, father vs. son, etc. In case of menu-based resolution, the conflict status as menu is provided to the potential conflicted residents. The conflict status includes service name and each resident's preference on the service, e.g. (resident A: TV service, Channel 7), (resident B: TV service, Channel 9), (resident C: Music service, song name), etc. Our goal for this investigation was to compare resident's negative feedback between the automatic conflict resolution and the manual conflict resolution way. We collected a total of 18 disobedience counts from our groups.

표 2. 자동 및 수동 해결 간의 거주자 불복종 비교. 불복종 비율 (%) = (불복종 횟수 / 충돌 횟수) X 100

Table 2. Resident's disobedience comparison between the automatic and the manual resolution. The disobedience rate can be calculated as follows: the disobedience rate (%) = (# of Disobedience / # of Conflict) x 100

	Families		Friends	
	# of count for conflict- occurrence	# of count for disobedience	# of count for conflict- occurrence	# of count for disobedience
Priority-based Resolving (Automatic resolution)	10	8	8	7
Menu-based Resolving (Manual resolution)	11	2	5	1

Our finding from this study is that technologies need not be completely hidden from residents. As shown in Table 2, the resident groups who were provided with automatic-conflict-resolving service had pretty much modified services. The disobedience rate of families and friends is 80 %, and 87.5%, respectively. Most of service modification had been done by lower-priority residents who did not get their service from home. According to interview, this is because there were not enough explanations why they could not get the services. However, the other groups who were provided with manual-conflict-resolving service had few modified services. With the pop-up menu, the residents could explicitly recognize that a conflict occurred, and actively participate in negotiation for choosing services. The disobedience rate of families, and friends is 18 %, and 20%, respectively. What made the residents modify service fewer times was that they believed their opinions affected conflict-resolution process. During such a negotiation, one resident could persuade other residents to be interested in his service. As a result, they enjoyed a service altogether in the same space without changing location of residents.

Of course, the quality of priority-based resolution might affect residents' disobedience. If priority-based resolution generates resident's priority from statistical patterns on choosing residents or service for a long time, the number of disobedience might be small. Unfortunately, it is difficult to use such a statistic data from just 3-hours usability test. However, according to interviews with our subjects, the residents who are not provided service may also disobey the result of accurate automatic resolution without enough explanation, and they will move to another space for the service. The reason of residents' disobedience is that the result of automatic conflict resolution persuades residents to recognize whose service is important or urgent, but not to be interested in the selected service. This makes the residents who are not provided services move to another place for their services. Therefore, accurate-automatic resolution without any interaction with residents will not improve significantly the harmonization of residents who are provided with automatically chosen services altogether if conflicts among them occur.

According to such a result, one of important factors for harmonious home environment is not only to solve some inconveniences on conflicting residents quickly, but to provide residents with interaction chances among them as much as possible through easy and simple technology.

V. Conclusion

In this paper, we proposed a new role of ubiComp-enabling technology in a home environment that is to harmonize family members who shares service resources in a space together. Our first approach for a harmonious home is how to avoid conflicts among residents from end-user's view points. As a result of user studies, conflict situation often occur when a resident enters a space where more than one resident is present, and an inhabited service finishes. In addition, for handling such a conflict, it is important that residents participate themselves in a conflict-resolving process by negotiation with others. Therefore, it avoids conflicts from daily life by enabling residents to negotiate themselves when a resident enters a space and an inhabited service finishes. This simplifies conflict problems at home by providing guidelines about when the conflicts appear and how to resolve the conflict. This can be one of important factors for implementing harmonious home environment that enables to strength relationship among family members by increasing time of their staying together for their services. However, for resolving conflict, residents negotiated with simple information, e.g. TV programs, music lists, etc. This often causes the residents to negotiate for a long time (in the worst case, more than 10 minutes). For reducing negotiation time among residents, as future works, it is necessary to investigate what method and information are provided to residents who have the control to resolve conflicts.

References

- [1] M. Weiser, "The computer for the 21st Century," *Scientific American* 265(3): pp. 66-75. September, 1991.
- [2] S. Meyer and A. Rakotomiariny, "A survey of research on context-aware homes," In *Proceeding of the Australasian Information Security Workshop Conference on ACSW frontiers 2003*, vol.21, pp.159-168, 2003.
- [3] D. Hindus, S.D. Mainwaring, N. Ledus, A.E. Hagstrom, and O. Bayley, "Casablanca: designing

social communication devices for the home", In Proceeding of CHI 2001, pp 325-554, 2001.

[4] K. Nagel, C.D. Kidd, T. O'Connell, A.K. Dey, and D. Abowd, "The family interacom: developing a context-aware audio communication system", In Proceeding of UbiComp2001, LNCS 2201, pp.176-183, 2001.

[5] F. Mattern, "The vision and technical foundation of ubiquitous computing", UPGRADE Vol.II, No.5, 2001

[6] V.Stanford "Using pervasive computing to deliver elder care", IEEE Pervasive Computing(Jan-March), pp.10-13, 2002.

[7] J. Hughes, J. O'Brien, and T. Rodden, "Understanding Technology in Domestic Environments: Lessonfor Cooperative builds", In Proceedings of the 1st International workshop on cooperative buildings, pp.246-261,1998

[8] C.Shin, W.Woo, "Conflict Resolution Method using Context History for Context-aware Applications," Pervasive 2005 workshop, pp. 105-110, 2005.

[9] Y.Oh, C.Shin, W.Jung, W.Woo, "The ubiTV application for a Family in ubiHome," 2nd Ubiquitous Home workshop, pp. 23-32, 2005.

[10] J.F. McCarthy, and T.D. Anagnost, "Music FX: an arbiter of group preferences for computer supported collaborative workouts", in Proceedings of CSCW'98

[11] C.Shin, W.Woo, "Conflict Management for Media Services by exploiting Service History and User," ubiComp workshop (ubiPCMM05), pp. 48-57, 2005.

[12] F. Otto, C. Shin, W.Woo , A.Schmidt, "How to Deal with Conflicts Resulting from Individual Input Devices in Context-Aware environments?," Advances In Pervasive Computing 2006, 207, pp. 65-68, 2006

저자소개

신춘성



2004.2. 숭실대학교 컴퓨터과학과 학사
2006.2. 숭실대학교 컴퓨터과학과 석사
2006.3 ~ 현재 광주과학기술원
정보통신공학과 박사과정

※ 관심분야: HCI, Ubiquitous/Wearable Computing

장세이



1997.2. 서강대학교 컴퓨터과학과 학사

1999.2. 서강대학교 컴퓨터과학과 석사

2005.10 광주과학기술원 컴퓨터과학 박사

2005.11 ~ 2007.8 나고야대학교

Post-Doc 연구원

2007.9~ 현재 삼성전자 기술총괄, Digital Solution 센터 책임연구원

※ 관심분야: HCI, Ubiquitous Computing, user-centric context modeling, context management in personal space and place,

우운택



1989.2. 경북대학교 전자공학학사

1991.2. 포항공대 컴퓨터과학석사

1999. University of Southern California 컴퓨터과학박사

1999 ~ 2001 일본 ATR 초청연구원

2001~ 현재 광주과학기술원

정보통신공학과 교수

※ 관심분야: 3D Computer Vision, Attentive AR, HCI, Context aware Ubiquitous Computing,

이상국



1987.2 인하대학교 전기공학학사

1989.2 인하대학교 전자공학석사

1994.10 프랑스국립응용과학원

(Institut National des Sciences Appliquees) 전자공학박사

1995.9~1999.8 프랑스국립

루앙(ROUEN Univ.)대학교 전기자공학부 조교수

1990.9~1999.8 프랑스국립응용과학원 PSI(Perception System & Information)연구소 연구원

1999.9 ~ 2001.8 삼성전자 중앙연구소 수석연구원

2001.9 ~ 2006.8 삼성종합기술원 Master(기술명인)

2006.9 ~ 현재 가톨릭대학교 멀티미디어시스템공학과 교수

※ 관심분야: Smart Sensor & System, HCI, Ubiquitous/Wearable Computing, Augmented Reality