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Context-aware Mobile AR system for Personalization, Selective Sharing, and Interaction of Contents in Ubiquitous Computing Environments

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1. Introduction

Now, the augmented reality (AR) systems have been developed to faithfully realize the basic concept that their main purpose is to supplement the real world with the addition of virtual objects (or information) to enhance a user's perception of and interaction with the real world (Azuma,1997; Azuma & Baillot, 2001). To this end, researchers in AR technologies have emphasized the technical challenges involved in providing accurate augmentation, natural interaction, and realistic rendering. With current advances in tracking and increased computing power, there have been corresponding developments in mobile AR systems. There have also been a number of studies pertaining to mobile AR technologies attempting to overcome these technical challenges (Pasman & Woodward, 2003; Wither et al., 2006; Billinghurst et al., 2000; Farbiz et al., 2005). However, we should consider more than just such immediate technical questions, but rather work to resolve issues related to possible interfaces and contents for user interaction in ubiquitous computing environments.

Several studies have adopted mobile AR technology to develop systems that offer potential interfaces and contents to users carrying a mobile device (Matsuoka et al., 2002; Geiger et al., 2001). Despite this provision, just providing every user with a uniform interface using mobile AR technology does not actually give much consideration to an individual user's desires, needs, and preferences. Also, with too much content, the use of mobile AR technology may cause users to become easily confused. In ubiquitous computing environments, various aspects related to the context of users and their environment can be utilized to provide a user with a personalized user interface and filtered contents.

There have been a number of efforts to support AR-enabling techniques using the notion of context-awareness (Henrysson & Ollila, 2004; Long et al., 1996; Feiner et al., 1997). However, these efforts have been mainly restricted to exploiting spatial contexts in adopting the notion of context-awareness in mobile AR systems. Nevertheless, there is a broad range of contexts available, ranging from physical to user contexts. This development has in turn led to a number of other efforts attempting to bridge between ubiquitous computing environments and mobile AR technology.

For instance, aPost-it was proposed as a context-based information augmentation and sharing system (Oh et al., 2004). However, this system only personalizes media contents through a webpage obtained from an object, and also lacks an efficient interface for controlling smart appliances in an intuitive and personalized manner. However, intuitive and personalized is the type of interface required to enable user's easy access to and customized control of pervasive and invisible smart appliances in a ubiquitous computing environment. In addition, for selective sharing of media contents in aPost-it, users have to explicitly inform the system whether they would like to share the contents through the user interface on the web page. Explicitly requesting the selective sharing of contents, however, is quite inconvenient for users.

Thus, in this paper, we propose a Context-Aware Mobile Augmented Reality (CAMAR) system. Besides enabling new ways of taking pictures of smart appliances in our daily life to control them, it brings innovative ways of associating context with multimedia-based interaction by enabling the interface and media contents to not only be personalized, but shared selectively and interactively among a group of people.The system is based on the ability to access contexts in a user's mobile device in a ubiquitous computing environment through a mobile AR technology-enabled interface.

On the one hand, it is generally agreed that "point-and-click" is the action of a computer user moving a cursor to a certain location on a screen (point) and then clicking a mouse button. In our system, we propose a point-and-click interface (Beigl, 1999) as the user interface, where users only need to take a picture of a smart appliance with a built-in camera in a mobile device to indicate their intention to control the appliance. The action of "taking a picture" is very similar to the one of "pointing" to indicate a user's interest. Similarly, the "click" of a mouse button to execute commands corresponds to the "control" of smart appliances. In this way, the system allows users to interact with smart appliances through a personalized control interface displayed on their mobile devices.

On the other hand, CAMAR supports enabling media contents to be not only personalized, but also shared selectively and interactively among a group of people based on mobile user's profile and context in ubiquitous computing environments. Even if separate users look into the same AR marker with a built-in camera in a mobile device, different media contents are augmented on their mobile device. Here, media contents are personalized as they are processed with context information. Then, the personalized media contents can be selectively shared within a community that our system implicitly constructs by analyzing context information.

Thus, by bridging a variety of contexts in ubiquitous computing environments and mobile AR technologies, the proposed system overcomes limitations in existing Information Technologies, which tend to provide the same information to all end-users. Applicable areas of the proposed system include mobile AR applications, such as a meeting system that supports information augmentation to a real environment for collaborations, a universal remote control for controlling various kinds of smart objects, and a mobile service agent that utilizes a user's location and activity to diversify and expand its use for mobile AR-based services.

This paper is organized as follows. In section 2, an overview of the CAMAR system including potential applicable scenarios is provided. We deal with implementations in Section 3, and Section 4 describes usability tests and observations. Finally, we conclude our work along with a brief outline of remaining work in Section 5.

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2. System Overview

In this paper, we present a Context-Aware Mobile Augmented Reality (CAMAR) system that supports two main functionalities. One is the intuitive and personalized control of smart appliances with mobile AR devices. The other is enabling media contents to be not only personalized, but also shared selectively and interactively among a group of people. The important foci of our system are as follows:

1) Controller augmentation (translate appearance to controller) –when a user takes a picture of a marker attached to a smart appliance through a mobile AR device, the system offers the user a personalized visual interface that can be used to control the smart appliance.

2) Multimedia augmentation (translate marker to contents) – when a user reads a marker embedded with contents (a digital map) through a mobile AR device, the system offers personalized media contents (photos) to the user.

2.1 System Features

Before specifying a concrete scenario, it is perhaps more useful to categorize the functionalities that such a scenario implies. A Context-Aware Mobile AR system aims at enabling the personalization and selective sharing of media contents as well as the mobile AR-based control of smart appliances in a ubiquitous computing environment. These aims are achieved as follows.

1) Support for easy and intuitive accessibility – the ubiquitous computing environment includes a large number of pervasive and invisible computing resources. Due to the multitude and invisibility of resources, it is difficult for users to make a use of those computing resources. Moreover, as the computing resources such as information appliances become smarter with more features, the accompanying user interfaces get complicated and becomes burdens for users (Badami & Chbat, 1998). In our approach, CAMAR supports the user-centered access of computing resources, especially smart appliances with the interface that is intuitive and easy to use. The user only needs to take a picture of computing resources with a built-in camera of the mobile device to indicate his intentions to access as in a "point-and-click interface."

2) Support for a personalized control interface – if computing resources become ubiquitous, then devices will be used in a wide range of dynamically changing environments. For these devices to be truly helpful to a user's interaction with smart services in this type of environment, they must be aware of both the environment as well as the user who is interacting with the services in the environment. To this end, CAMAR supports the personalization of a smart appliance controller that adapts based on what the user's interface usage patterns are. Our system supports a personalized control interface by generating a customized control menu that best suits the user's needs in controlling smart appliances. It allows the system to provide an intuitive and transparent user interface such that the user can concentrate on the original task.

3) Support for context-based media content provision and selective sharing – a user will be supplied with a potentially overwhelming amount of media contents in a ubiquitous computing environment. To assist the user in avoiding confusion, the development of a personalized content provider is needed, one that adapts based on who is present and what their preferences are. For this reason, CAMAR allows different media contents to be augmented to individuals even if they look at the same marker. Another key theme of

ubiquitous computing systems is the support for groups of people (Kohno & Rekimoto, 2005). For selective sharing of media contents in the ubiquitous computing systems, users generally do not like to explicitly inform the system of whether or not they would like to share the contents through conventional user interfaces. Thus, this system allows personalized media contents to be selectively shared within a community that our system implicitly constructs by analyzing context information. It specifically enables selective sharing of common knowledge and experiences of contents interactively and collaboratively among a group of people. Fig. 1 shows the concept diagram for a CAMAR system supporting mobile AR-based control, personalization, and community-based selective sharing.
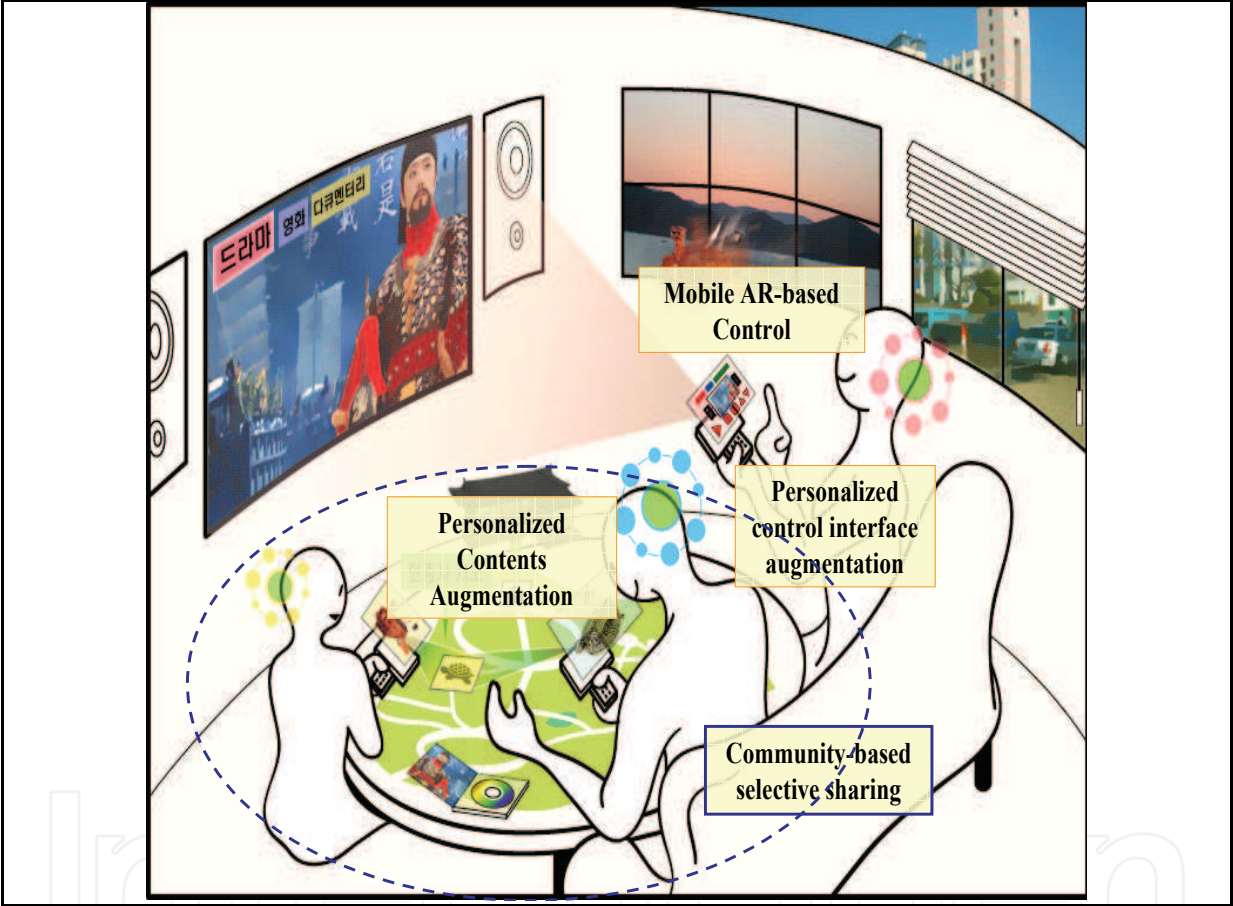

Fig. 1. Concept diagram for a CAMAR system

2.2 Applicable Scenarios

As a test-bed for a ubiquitous computing environment, we used a smart home which has been established in our laboratory. In addition, as a test-bed for content, we used information on a specific domain, the Unju Temple (Lee et al., 2005), to allow our test data to include photos and detailed 3D models of places (Lee et al., 2005). Fig. 2 shows a conceptual diagram of the system, suggesting potential scenarios applicable to the CAMAR system. A typical scenario is outlined as follows.

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Fig. 2. Visualization of overall scenarios applicable to the CAMAR system

1) Easy and intuitive accessibility: Embedded marker-based and personalized smart appliance control using a mobile device.
When a user takes a picture of a specific smart appliance with a built-in camera in a mobile device, a controller for the captured smart appliance can be augmented on the mobile device: a smart TV controller, a smart table controller, a smart window controller, and/or a smart light controller.

Scene #1	*Hyoseok comes home from work. He becomes aware of the fact that his wife Hyejin went to a market in the neighborhood. As soon as he comes into the living room, the lighting service prepares the green lighting he usually prefers at this time of day. He changes the color of lighting to a blue one since he feels the weather is so hot, and wants to make the room feel a little more refreshing.*
Description	A user takes a picture of a light switch covered with an embedded marker in consonance with an on-off switch. After that he can control the functions of the lighting service. Also, he can confirm other available service lists from the service discovery on his mobile device.
Scene #2	*Then, Hyoseok approaches a smart TV. The smart TV recognizes that he might approach close to it. Hyoseok selects a sports channel using the smart TV controller on his mobile device and begins to watch TV.*

Description	A user can take a picture of the visible marker displayed on the TV as a kind of screen saver.
Scene #3	*Hyejin then returns home from the market. After she confirms that Hyoseok has selected a sports channel to watch on TV, she moves to a smart window. She begins to control a service of the smart window that allows her to navigate a virtual view of Unju Temple. After she entertains herself by viewing the virtual navigation system, she comes over to the smart TV. When she is in front of the smart TV, a control hand-over button appears on Hyoseok's smart TV controller on his mobile device. As soon as Hyoseok transfers his control of the smart TV to Hyejin, a visual marker indicating control transfer completion is displayed in the upper-right corner of the smart TV. Hyejin then takes a picture of the visual marker. Simultaneously, the smart TV recognizes that Hyejin has obtained control from Hyoseok and provides a recommendation menu based on Hyejin's preferences. Hyejin selects a cooking channel using the smart TV controller on her mobile device and begins to watch TV.*
Description	In this situation, the second user is supplied with a personalized control menu interface that suits her best. She can control the smart appliance, in a personalized manner, by using the personalized menu interface on her mobile device.

Table 1. Description of the scenario applicable to the personalized smart appliance controller

Table 1 and Fig. 3 show a description and visualization of the scenario applicable to the Personalized Smart Appliance Controller, respectively.

Fig. 3. Visualization of the scenario applicable to the Personalized Smart Appliance Controller

2) Context-based media content augmentation and sharing

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Scene #1 (*Hyoseok returned from visiting Unju Temple last week*)	*Hyoseok visited the Unju Temple with his family last week. He really loves taking photographs, so he took a number of pictures of the precincts of the Unju Temple. The photos were spatially indexed through a GPS-receiver in the mobile device that was used to take the photographs, allowing Hyoseok to later know where a certain photo was taken. Hyoseok decides to recommend that his friend Youngmin visit the Unju Temple, so he invites his friend over to his home to show him the pictures of his visit last week. Because it has already been a week since he visited, it is difficult for Hyoseok to remember exactly when and where he took which shots. For this reason, Hyoseok likes to reminisce about the Unju Temple through a smart table and navigate the paths of the virtual Unju Temple. He then recognizes at a glance the places he took the pictures through the map displayed on the smart table. Hyoseok moves his mobile device, just like looking through a magnifying glass, to a specific region on the map to see the pictures he took in the region. Thus, Hyoseok can enjoy the pictures augmented on the screen of his mobile device.*
Description	In this situation, only the media content with a high degree of similarity to his specified preferences are recommended and augmented.
Scene #2 (*Hyoseok with his son Hyunmin*)	*Hyunmin visited the Unju Temple with his dad last week, and so cares to join his dad visiting a virtual Unju Temple, after coming back from school. The places at which Hyoseok took the pictures are indicated through makers displayed on the map on a smart table. "Wabul" in the map is indicated by a distinguished marker. Hyoseok decides to look into that place moving his mobile device with his hands to that location. Hyunmin also gets interested in the "Wabul" and looks at it on the map since he remembers he had taken some pictures with his dad at the rock. They begin to talk about how they felt at the time while in that place. Then, Hyoseok wishes to share pictures, of which he is thumbing through, with his son in which they appear together. On Hyoseok's pressing a button in his mobile device for sharing, Hyunmin receives and enjoys the pictures as well.*
Description	In this situation, Hyoseok's photos of "Wabul" tower are delivered to *Hyunmin's* mobile device. In this way, Hyunmin can share Hyoseok's experiences via the photos augmented on his mobile device.
Scene #3 (*Youngmin visits Hyoseok's home*)	*Youngmin has never visited the Unju Temple, and so decides to visit a virtual Unju Temple using Hyoseok's smart table, after hearing from Hyoseok that the Unju Temple is quite unlike other temples. The places at which Hyoseok took his pictures are indicated through markers displayed on the map on the smart table; for instance, "Wabul" tower in the map is indicated by a distinguished marker. Youngmin decides to look at that place by moving his mobile device closer to that marker. Hyoseok wishes to share his experiences of "Wabul" tower with Youngmin by sending him pictures of his previous visit, so he presses the sharing button on his mobile device. Youngmin looks at the pictures and feels that "Wabul" rock in the Unju Temple is indeed impressive. Thus, he becomes interested in the temple with the help of content augmentation on his mobile device.*
Description	In this situation, Hyoseok's photos of "Wabul" tower are delivered to Youngmin's mobile device. In this way, Youngmin can share Hyoseok's experiences via the photos augmented on his mobile device.

Table 2. Description of the scenario applicable to a context-based content augmentation and sharing service

Table 2 and Fig. 4 show a description and visualization of the scenario applicable to a context-based content augmentation and sharing service, respectively.
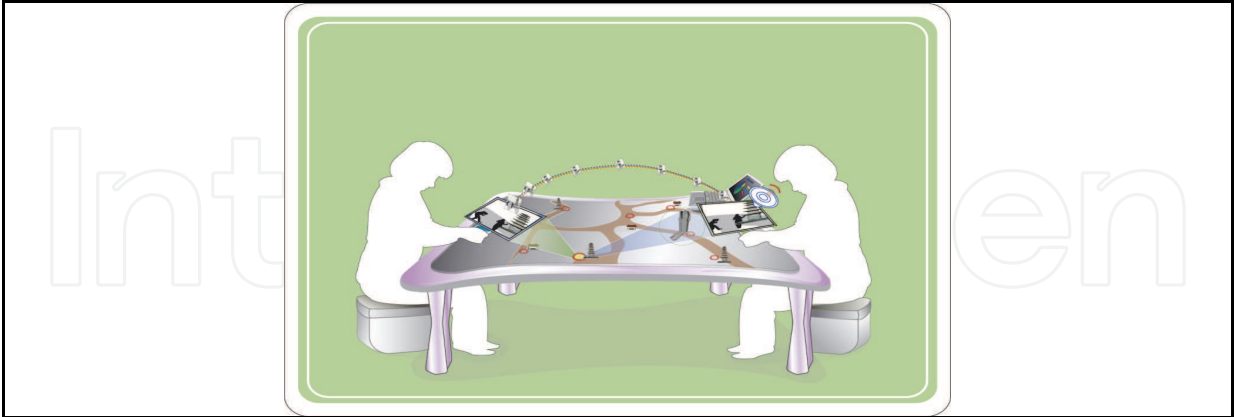

Fig. 4. Visualization of the scenario applicable to a context-based content augmentation and sharing service

3. System Details

Here, we identify the main components for a system targeting the main challenges of smart appliance control, personalized content, and selective sharing of personalized contents. To this end, Fig. 5 shows the overall system block diagram of CAMAR.
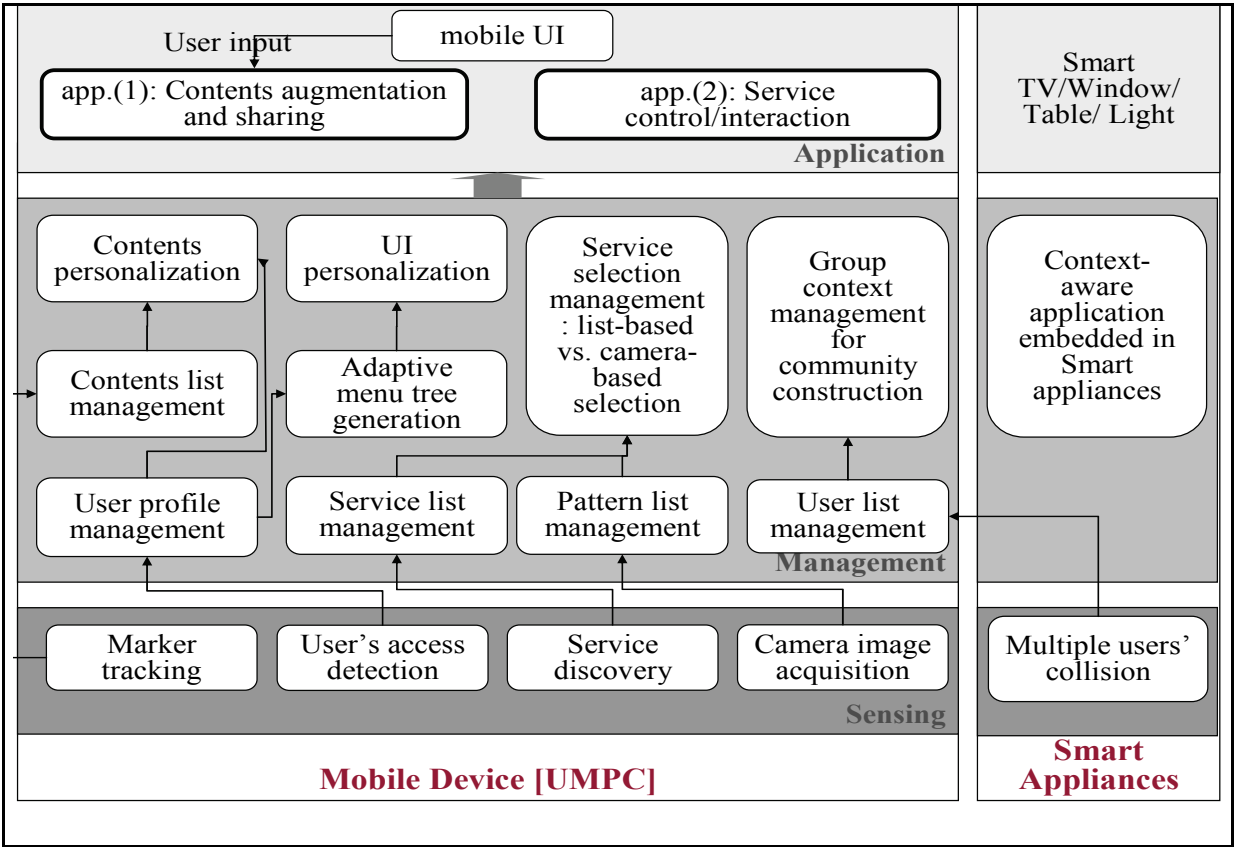
Fig. 5. CAMAR system block diagram

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3.1 Easy and intuitive accessibility for ubiquitous computing resources

To support smart appliance control, we have designed a camera-based method along with a set of logical modules for service discovery, service selection, and service interaction. In the sensing layer, a user's personal mobile device can discover and visualize potential services in the environment. Specifically, the built-in camera is used to recognize and identify smart appliances that can later be personalized. In order to recognize smart appliances, we either embed markers into the appliances or use the physical features of a smart appliance as the marker. In this way, smart appliances with a display such as ubiTV, MRWindow, and ARTable (Oh et al., 2005; Park & Woo, 2006) display a screen saver while in ready-mode, which later changes into a visible marker when the user is in the effective service area. In terms of the use of physical features, features of a light switch can be used as an embedded marker for the light service. Then, in the management layer, after the user selects a service through either a list-based or camera-based method, the user's context is exploited to personalize the user interface. Subsequently, the same logical flow can be further developed to control a number of smart appliances, which can then be included in one universal remote controller. Fig. 6 shows the procedural diagram for smart appliance control.
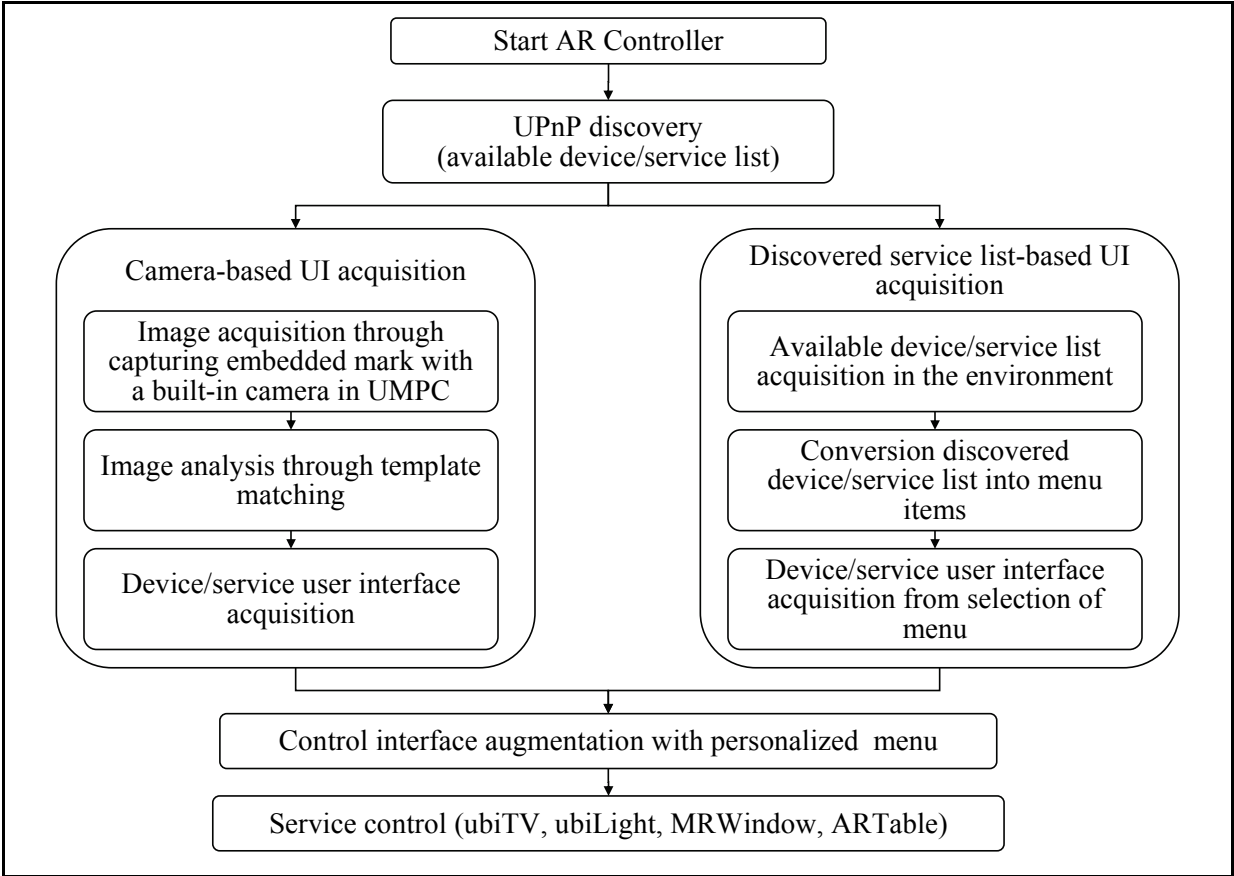

Fig. 6. A procedural diagram for an AR Controller

The smart appliances and services in this environment are implemented with ubi-UCAM (Unified Context-aware Application Model for Ubiquitous Computing Environment) (Oh et al., 2005) to enable context-awareness. Context-aware services are deployed into smart appliances to collect, integrate, interpret, and/or manage the user context to provide

personalized services. For effective use of computing resources, context-aware services recognize each user's preferences and service status to detect conflicts. Then, when/if conflict occurs, the service profile of the conflicting service and the user profiles of the users in the conflict situation can be utilized to form a recommendation for a unified context (Jang & Woo, 2005). Thus, a conflict-free context can be delivered to other service providers and into the environment.

3.2 Personalization of control interface

When providing users with a smart appliance AR controller, menu tree organization in the control interface was our main consideration in terms of the personalization of the user interface. Mobile devices are becoming ever smaller, allowing users to make the most out of their portability and convenient manipulation. Thus, it should be possible to display a large amount of data in such a way that a users' satisfaction of data selection can be enhanced. In our work, personalization of the control interface aims to relieve the user from scrolling through screens and exploring a multi-layered menu structure by providing a simpler menu interface that best suits the user. This simplification is achieved by analyzing the user's usage pattern of the menu interface in his mobile device; first, the information pertaining to the menu items used as part of the user's interaction with his mobile device is collected and managed as a history.

We can then simplify the menu structure in the control interface using the history data collected over a certain period of time. Note that the menu items we simplify may involve the full range of items on the menu. The basic method we consider is to learn the frequency of selection of the menu item. However, this method may give rise to wrong results because the frequency in selecting the upper and middle levels of the menu gradually increases regardless of the user's intention. To overcome this inaccuracy, we used a reciprocal scoring method that includes the position information of the menu in the interface. In equation (1), indicates the score of menu x, the depth of the menu, and the constant.

$$q_x^{d-1} = \sum_x \frac{K}{q_x^d} \ (if \ q_x^d = 0 \ then \ set \ \frac{1}{q_x^d} = 0) \tag{1}$$

The order of the menu item is determined by the score calculated by (1) and then displayed in the user's mobile device.

3.3 Context-based contents augmentation and sharing

To consider the personalization of media contents, we developed a photo content recommendation module based on the user profile and the symbolic location information of the virtual heritage map displayed in a smart table. We exploit the metadata of the photos that were already spatially-indexed by the GPS-receiver in the mobile device that was used to take the photograph. First of all, we filter the photo contents shot at the sites that correspond with the symbolic location information of the virtual map in the smart table. Then, we use the user preferences with respect to the photo contents to draw up a list of photo contents and recommend them to the user. As a method for recommending photo contents based on user preferences, we use a similarity measuring equation (2) (Yu et al.,

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2006). Here, the user preference (P) and the metadata of the photo contents (C) are described in terms of the vectors, $P = (w_1, \mathrm{K}, w_n)$ and $C = (u_1, \mathrm{K}, u_n)$, respectively. In this representation, w_i is the weight value of the users on a certain property of the photo contents, and u_i is the weight value of the photo contents on the property corresponding to w_i .

$$Similarity(C, P) = \frac{C \cdot P}{\| C \| \times \| P \|} = \frac{\sum_{i=1}^{n} u_i w_i}{\sqrt{\sum_{i=1}^{n} u_i^2 \sum_{i=1}^{n} w_i^2}} \tag{2}$$

The fundamental context information we can acquire in this aspect includes the time when we took the photograph, and the location of where we took the photograph.

Context Element	Meaning	Description
Who	Who the user is	User ID
When	When the interaction takes place	The time the picture is taken at. The time the user interacts with contents in ARTable.
Where	Where the user is	Spatial context when taking the picture at the real Unju Temple.
		Spatial context when exploring the virtual Unju Temple in the virtual world displayed on ARTable.
What	What the interaction is about	Service ID Content ID
Why	What the user is interested in	Preferences: mathematics, photography, history, etc.

Table 3. Context information used in the system

Types of 5W1H context information (Jang & Woo, 2005) used in our system are described in Table 3. Additionally, the system generates and manages group context by extracting common preferences through an analysis of multiple users' integrated contexts and their relationships. After managing the group context, it selectively allows users with common interests to share contents. Fig. 7 shows the overall process of the phase in which one user has priority over another in enjoying context-based content augmentation and sharing in ARTable.
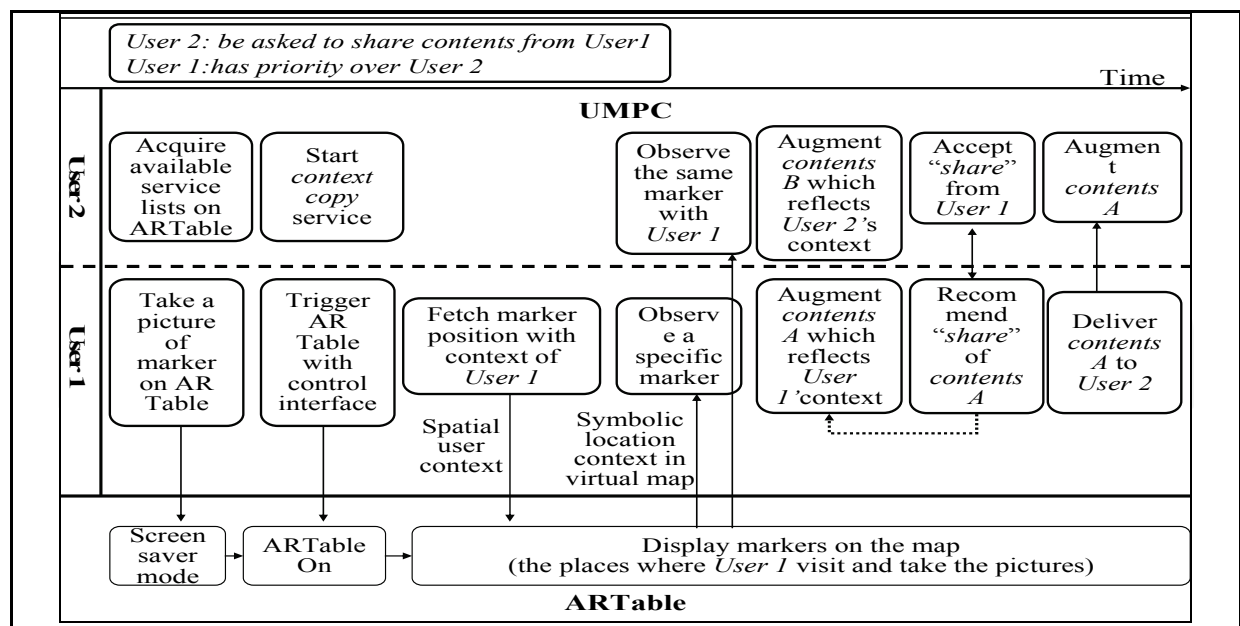
Fig. 7. Process flowchart for context-based content augmentation and sharing in ARTable

4. Implementation

We implemented a Context-Aware Mobile Augmented Reality (CAMAR) system that supports two main functionalities. One is the control of smart appliances with mobile devices. The other is enabling media contents to not only be personalized, but also selectively and interactively shared among a group of people. Table 4 describes the CAMAR system platform.

HW/SW	Specification
UMPC	SONY VAIO VGN-UX-17LP[1]
OS	Microsoft Windows XP Professional
Software Development IDE	Microsoft Windows Visual Studio 2005
Camera Library	OpenCV beta 5[2]
Image Processing Library	ARToolkit 0 Glut 3.7.6[3]
UPnP SDK	Intel® Authoring Tools for UPnP Technologies (Build1825) Intel® Tools for UPnP Technologies (Build 1768)

Table 4. System Platform

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[1] http://vaio-online.sony.co.kr/

[2] http://sourceforge.net/projects/opencvlibrary

[3] http://www.xmission.com/~nate/glut.html

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1) Smart appliance control: Controlling smart appliances with mobile devices

A Personalized Smart Appliance AR Controller is a mobile user interface that enables users to control smart appliances in a personalized manner using a mobile device with a built-in camera. Most mobile devices have only one dedicated user, making it easy for a mobile device to provide a personalized interface. For example, a mobile device provides an interface that is consistent with the interface for smart appliance that the user is familiar with or prefers. In this way, we designed and implemented the Personalized Smart Appliance AR Controller to allow users to control smart appliances in the environment through a personalized user interface. When a user wishes to control a smart appliance, he or she only needs to take a picture of it with the built-in camera. Then, the personalized and tailored service interface is automatically augmented on the mobile device. The controller device processes the pattern matching, obtains contextual information that contains an abstract functional description from the smart appliance, and uses the contextual information of the description to properly generate a personalized user interface.

The Personalized Smart Appliance AR Controller provides four main functions. The first function is the personalization of the mobile user interface. The second function pertains to service notification in terms of discovering devices and services in a user's home network environment. The third function is that a single mobile device such as PDA functions as a universal remote control for multiple devices and services. Lastly, when/if a service conflict occurs, i.e., you are prohibited from using a certain service because it is pre-occupied by another user, service recommendations and service control hand-over functions can be used to resolve any conflicts. Fig. 8 and Fig. 9 show smart appliance control functions in a UMPC version and a PDA version, respectively. The personalized controllers for smart appliances augmented on the mobile devices include ubiTV Controller, MRWindow Controller, ubiLight Controller, and ARTable Controller.
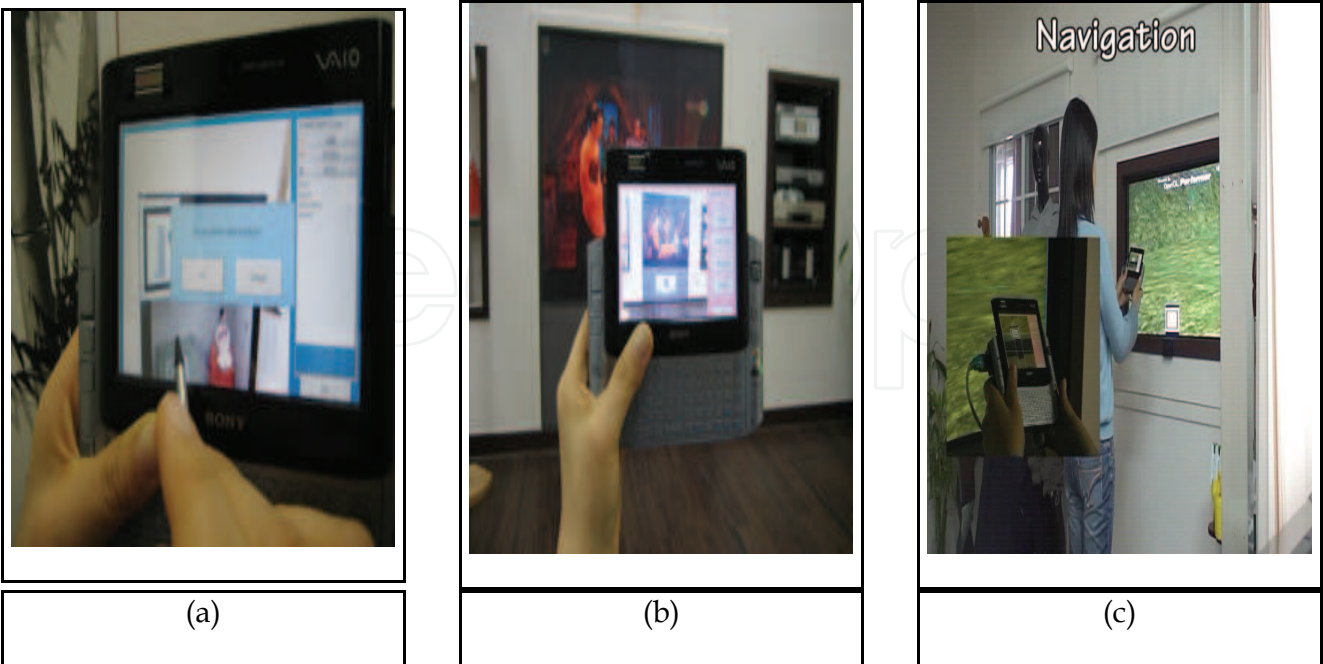
(a)	(b)	(c)

Fig. 8. Smart appliance control with AR Controller embedded in UMPC, (a) taking a picture of the ubiLight service, (b) controlling the ubiTV service, and (c) navigating in VR contents
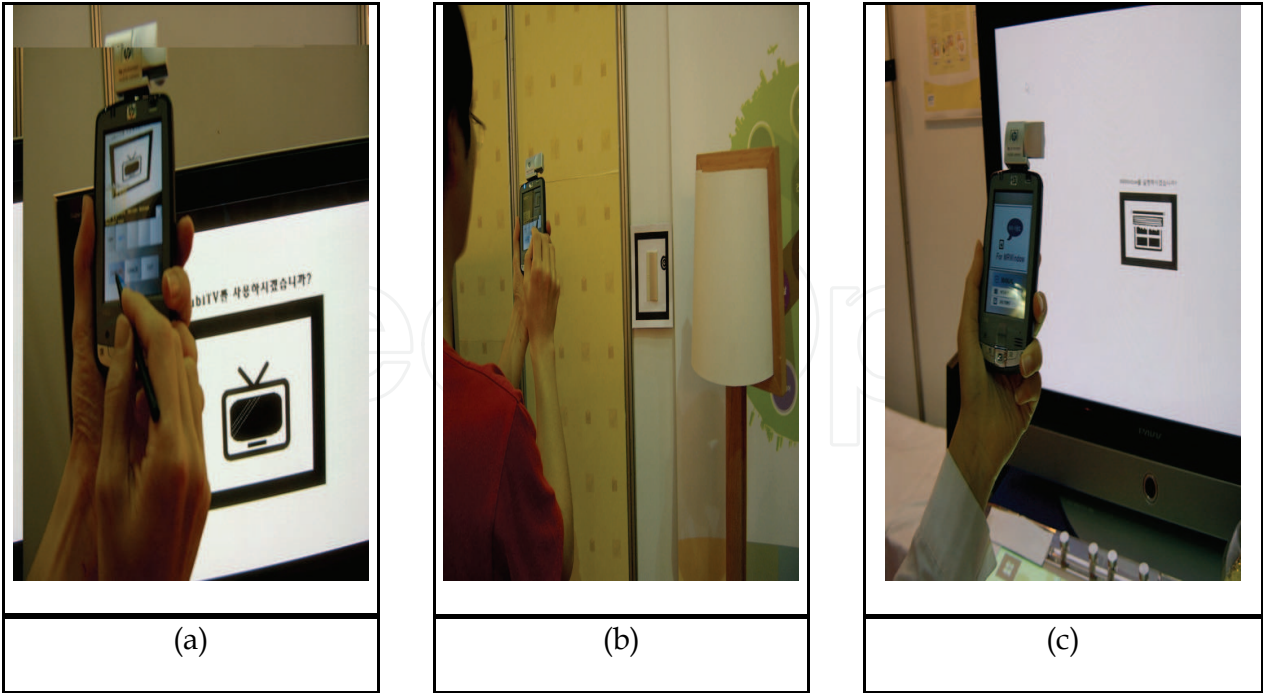
Fig. 9. Smart appliance control with AR Controller embedded in a PDA, (a) controlling the ubiTV service, (b) taking a picture of the ubiLight service, and (c) taking a picture of the ubiTV service.

As prototypes, the AR Controller is implemented in both PDA and UMPC platforms. Here, the PDA platform has an advantage because it is relatively smaller, cheaper, and more portable. However, the UMPC platform performs better in image processing for pattern matching. Thus, for research purposes, we used both platforms interchangeably to develop compatible components for both the PDA and UMPC platforms. Fig. 10 shows two different versions of the AR Controller.
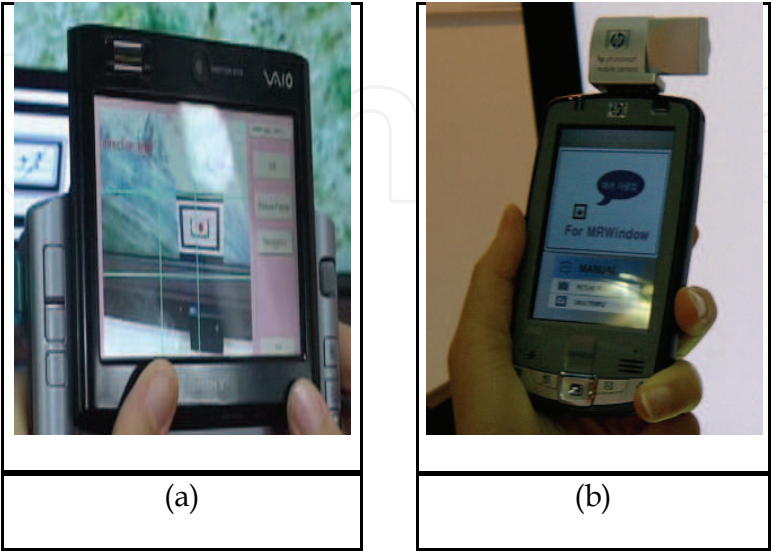
Fig. 10. AR Controller in (a) UMPC platform and (b) PDA platform

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2) Context-based content augmentation and sharing

To present content augmentation and sharing with mobile AR technologies, we implemented an edutainment system that augments photos taken in a site and allows users to share them. As shown in Fig. 11, we used ARTable to display a navigation map and AR markers, and UMPCs to augment and share the photo contents. We selected Unju Temple as the site and temple photos as the contents to augment and share.
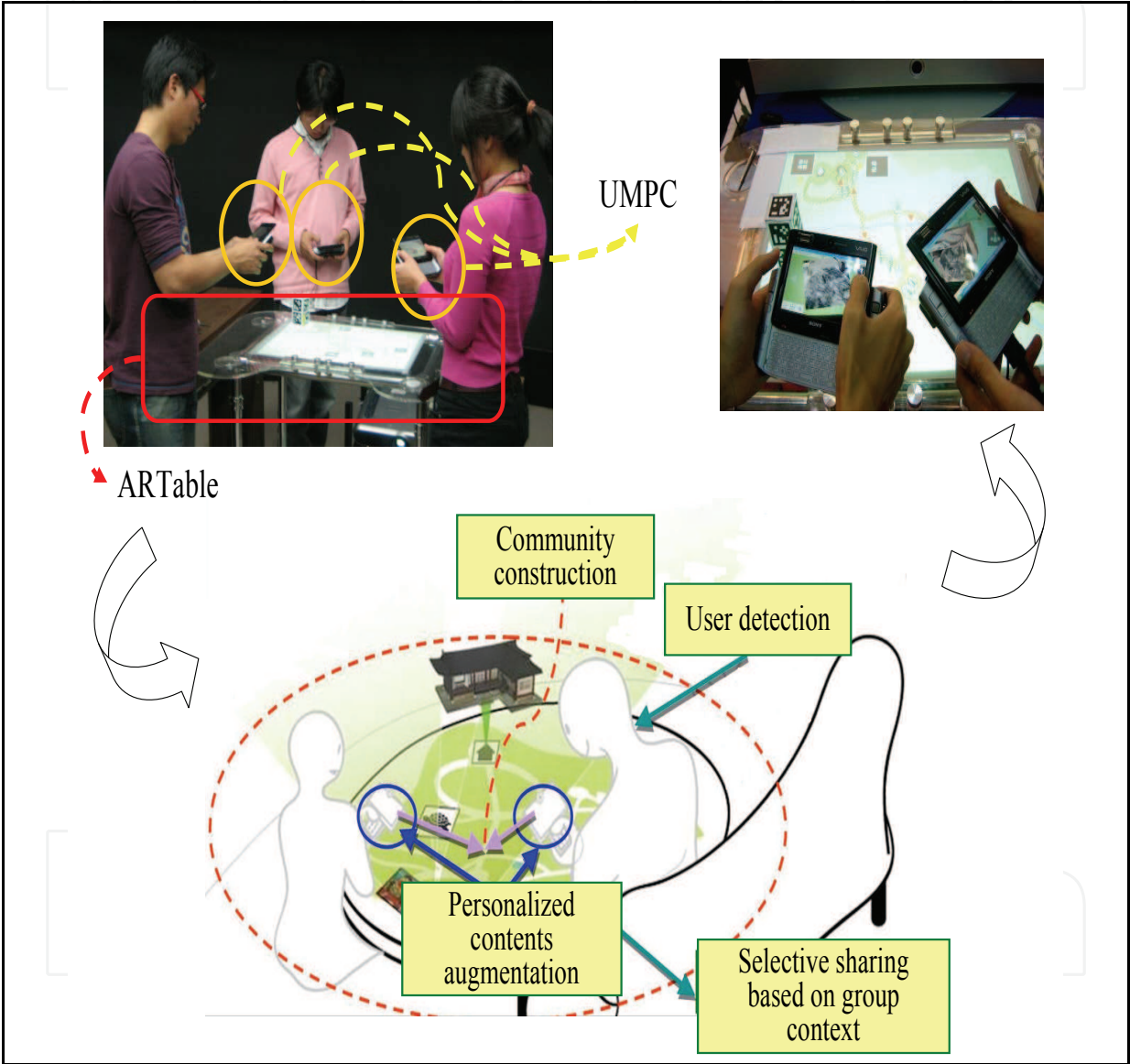
Fig. 11. System overview of context-based content augmentation and sharing system

When we explore a cultural site, we tend to take pictures of cultural assets and save them in our mobile device to record our memory or experience. Then, from the photos or video data the visitor can revisit the moment of visiting a cultural heritage site. Our system aims to realize Context Copy by extracting contexts, providing personalized media contents, and having them shared through mobile AR techniques. To this end, Fig. 12 shows a context-based photo content augmentation and sharing system for realizing the concept of Context Copy.
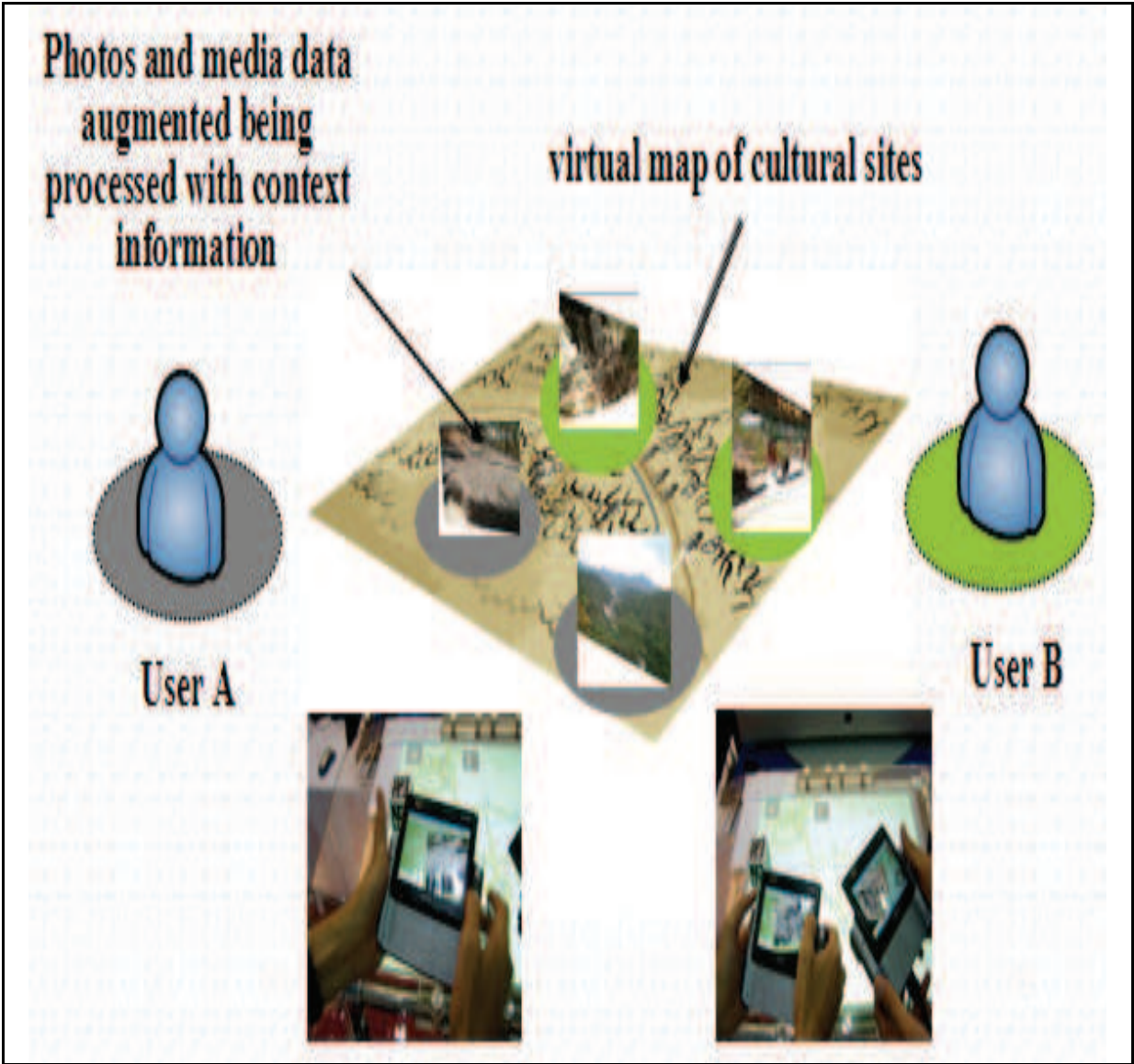
Fig. 12. Context-based photo content augmentation and sharing system for Context Copy

The personal context information such as time, location, etc. is managed in an individual mobile device. We allowed our system to show the distinct personalized media contents of two users depending on whether or not the user has visited Unju Temple. Here, we assumed that User A has been to Unju Temple, and that the pictures he took at several places around the temple are saved in his UMPC. When User A looks at a specific AR marker on a map on ARTable with his UMPC in his hands, the pictures he took at that place are augmented. Then, User A can flick through the pictures one by one. Here, the pictures are augmented in order of User A's preferences. ARTable (Park & Woo, 2006) is a smart table in which contents are dynamically displayed as a reaction to a user's interaction. In our system, ARTable constructs a space that allows multiple users to interact with services; here, a map with the paths around Unju Temple is displayed. To indicate a specific site on the map, we designed a particular AR marker in consonance with the surroundings in the map, and the system allows these markers to be detected. We extracted context appropriate

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information for application to this kind of system. The context information that is brought
into play in the first phase is the location information on the sites the user has visited and
taken pictures of. As shown in Fig. 13, ARTable displays a customized map of Unju Temple
with the sites that the user has already visited indicated by AR markers. In addition, the
larger the number of photos taken at a specific place, the larger the size of the marker
indicating the place.
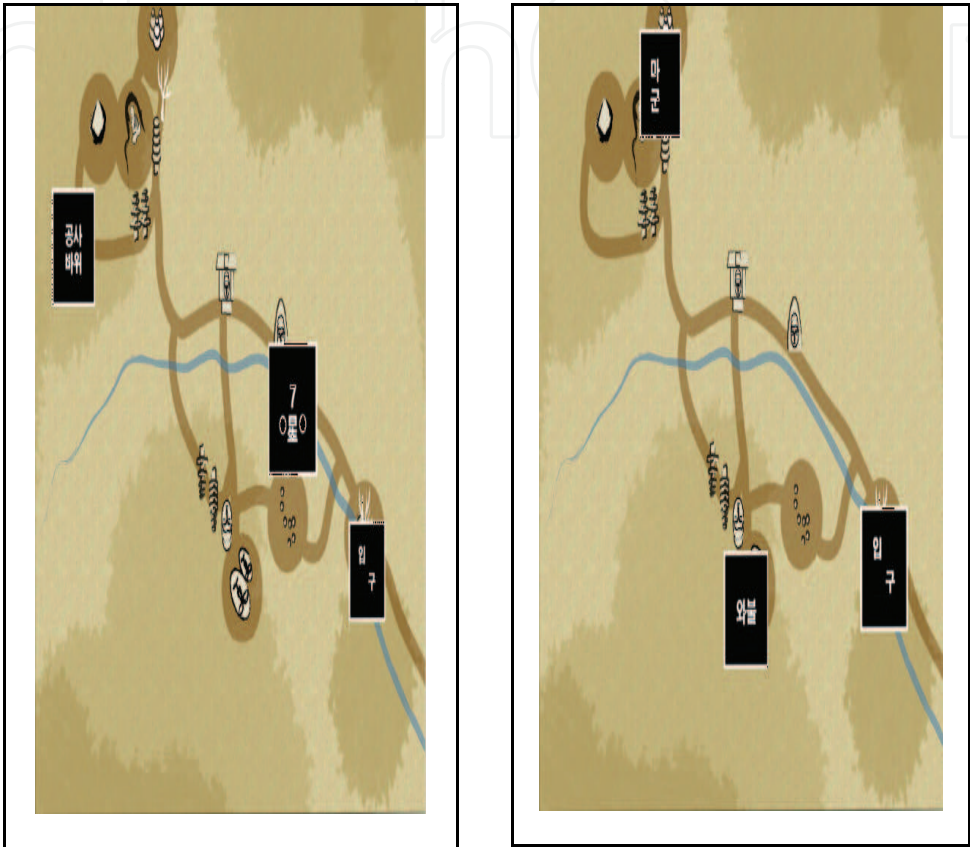
Fig. 13. Customized map of Unju Temple with the sites visited by the user indicated by AR
markers

In the user's mobile device, the photos based on his or her context are then augmented. To
determine the photos to augment, our system investigates if they are taken at the
corresponding places as the specific marker that the user looks at with the built-in camera
from among the markers displayed on ARTable. If we assume that User B has never been to
Unju Temple, then the photos of Unju Temple would not exist in his UMPC. Thus, when
User B uses his UMPC to view the same photo as the AR marker that User A sees in the map,
the photos relating to that place are not augmented. Our system just provides the general
information relating to that place without any personalized content augmented on the
marker, as User B has no personal experience of visiting Unju Temple. In this context, User
A has the option of then delivering the augmented photos from his UMPC to User B,
allowing User B an opportunity to look at these photos. In addition, User B can receive
abundant information related to the place through sound or animation augmentation. To
this end, Fig. 14 illustrates context-based photo content sharing

Fig. 14. Context-based photo content sharing

5. Conclusion and Future works

With this exploratory study on CAMAR, we have shown a novel way of using context in a multimedia-based interaction that breaks from the preconceptions originating from the limitations of conventional AR applications. We believe that our work demonstrated the feasibility of personalized smart appliance AR controllers as well as context-based content augmentation and sharing systems. Besides enabling new ways of taking pictures of smart appliances in our daily life to control them, CAMAR broadened the possibilities of using context as a resource in new multimedia-based interaction techniques that naturally bridge the interface between human and mobile devices. Nevertheless, we need to conduct further user studies to see how useful our system is and accepted as a means of interaction for potential consumers by comparing with similar existing systems. Then, by considering the compatibility of the embodied technologies and contents, we will try to determine better contents for supporting the concretizing of user's experiences and sharing something meaningful to families through a CAMAR-embedded device. Moreover, to increase the satisfaction of the embodied technology, we should investigate the possibilities for controlling various smart but complex appliances with an intuitive interface on CAMAR-embedded devices. Subsequently, it will be valuable that we design CAMAR core platform to meet the system requirements and integrate them into an extensive framework.

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Human Computer Interaction

Edited by Ioannis Pavlidis

This book includes 23 chapters introducing basic research, advanced developments and applications. The book covers topics such us modeling and practical realization of robotic control for different applications, researching of the problems of stability and robustness, automation in algorithm and program developments with application in speech signal processing and linguistic research, system's applied control, computations, and control theory application in mechanics and electronics.

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