u-Contents : New kinds of realistic contents in ubiquitous smart space

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***Abstract*—According to ubiquitous computing paradigm, the type of realistic contents is changed to be suitable for our daily life. In this paper, we introduce u-Contents which provide new kinds of realism suitable for users in ubiquitous smart space. The u-Contents improve realism based on personalized multimodal feedback. They enable for users to share the contents with other users. Moreover, they evoke users' interest through personalized response suitable for users' experience, preference, emotion, etc. Therefore, u-Contents have three main characteristics; u-Realism, u-Mobility, and u-Intelligence. We analyze researches related to develop realistic contents, and then describe future direction of essential researches to realize the proposed u-Contents,. We also present possible scenario by applying proposed u-Contents to smart home environments. Therefore, we expect that the u-Contents show potentials as new kinds of realistic contents proper to ubiquitous smart space.**

Index Terms—Ubiquitous Smart Space, Realism, Mobility, Affective Contents

I. INTRODUCTION

Accrding to ubiquitous computing paradigm and the development of smart objects, requirements for realistic contents are changed [1, 2]. The type of realistic contents is also changed to be suitable for our daily life [3]. Moreover, there are several researches to offer contents proper to users' contexts [4-6]. However, they only provide nonrealistic contents which can not present high quality of realism. In order to overcome the limitation, the contents should offer suitable realism for users in ubiquitous smart space.

Many researchers have studied on developing realistic contents which make users feel as if they actually experience the contents. However, they are focused on realism based on the sense of sight and hearing. Although the realism depends on users' characteristics, e.g., the degree of experience, background knowledge, etc., the current works only offer same contents without any consideration about the characteristics. Thus it is one of reasons to reduce users' realism about offered contents.

In this paper, we introduce u-Contents which provide new kinds of realism suitable for users in ubiquitous smart space. U-Contents offer the realism based on five senses according to users' context. It is freely transferred to any devices in ubiquitous smart space. The u-Contents sympathize with users' emotional state through reaction suitable for users' emotion. Therefore, u-Contents have three main characteristics; u-Realism, u-Mobility, and u-Intelligence.

The proposed u-Contents have following advantages. First, they improve realism based on personalized multimodal feedback with u-Realism. They enable for users to share the contents with other users through u-Mobility. Moreover, they evoke users' interest through personalized response suitable for users' experience, preference, emotion, etc, based on u-Intelligence. Therefore, the u-Contents show potentials as new kinds of realistic contents proper to ubiquitous smart space.

This paper is organized as follows. In chapter 2, we describe detailed characteristics of u-Contents. In chapter 3, we analyze related works, and then show essential researches to realize u-Contents. In chapter 4, we present possible scenario based on proposed u-Contents. Finally, we discuss the conclusion and future works, in chapter 5.

II. DEFINITION OF U-CONTENTS

u-Contents are new kinds of realistic contents suitable for ubiquitous smart space. They have three main characteristics; u-Realism, u-Mobility, and u-Intelligence. Therefore, u-Contents offer realism based on users' five senses, and enable to selectively share with others. They also present personalized reaction suitable for users.

A. u-Realism

u-Realism provides realism suitable for users' context through multimodal feedback based on users' five senses. It enables users to augment any contents to existing contents naturally. It also makes users experience actual feeling through multimodal feedback. Moreover, it maximizes realism with personalized adjustments proper to users' sensibility on five senses.

B. u-Mobility

U-Mobility is to freely move contents to any devices or smart objects in ubiquitous smart space. It enables to move contents from devices or objects to users' mobile device, and makes users share the contents with their wanted users selectively. It also allows to reflect users' manipulation to the shared contents. Thus, the u-Mobility supports collaboration between users through the contents.

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C. u-Intelligence

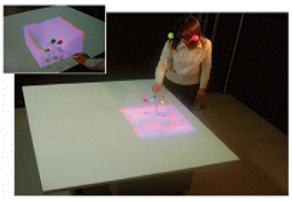
U-Intelligence provides personalized responses suitable for users' context, e.g., intention, attention, emotion, etc, through intelligent agents. The agents perceive the users' context from extracted information through distributed sensors in ubiquitous smart space. It also reflects the context to contents for generating personalized responses according to the users. Furthermore, it presents autonomous reaction to improve interaction with users.

III. RELATED WORKS

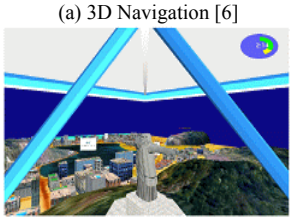
In this chapter, we analyze related works by the view of above characteristics; u-Realism, u-Mobility, and u-Intelligence. We show essential researches to realize the u-Contents, and present future works of the researches.

There are several researches, as shown in Figure 1, to offer realism through multimodal feedback. In Figure 1(a), it provides vision-based realism with users through navigation of 3D virtual environments consisted of photo-realistic contents [7]. In VR Theater, it makes participants experience realism based on the sight, hearing, and smell in large theater [8]. In Figure 1(b), it lets users experience musical instrument performance through touch feedback with air jet [9]. In Virtual Hang-gliding, it allows users to experience hang-gliding virtually through multimodal feedback, i.e., stereoscopic images, wind effect by fan, etc [10]. However, most works are focused on reproduction about actual ones. Since they do not consider users' characteristics, they only offer same contents to different users.

(a) 3D Navigation [6]



(b) Virtual music player [8]

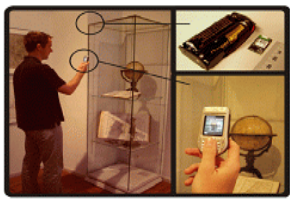


(c) Virtual hang-gliding [9]; stereoscopic images(left), multimodal feedback(right)

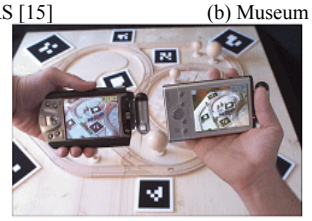
Figure 1. Related works to realistic multimodal feedback

Researches on mobile contents have studied by using mobile devices, and focused on mobility of contents [11-14]. Figure 2(a) shows MARS (Mobile Augmented Reality Systems) which offers augmented contents through portable computers in mobile computing environments [15]. Bruns, et al. introduces museum guidance system, as shown in Figure 2(b), which provides information related to exhibition through mobile phone with camera [16]. In Invisible Train, it shows augmented reality system that it allows multiple users to access and manipulate dynamic contents in shared space, and supports collaboration about the contents with the users [17]. These works keep the accent on accessibility to contents through mobile devices. However, they only offer non-realistic and uniform contents to users. Thus, they are not satisfied with users' requirements for realistic contents.

(a) MARS [15]



(b) Museum Guidance [16]



(c) Invisible Train [17]

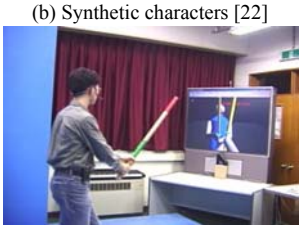
Figure 2. Mobile contents with mobile devices

Many researchers have studied on virtual characters autonomously interacting with users [18]. Bate, et al. propose believable agents which show autonomous responses in story telling system [19, 20]. In Figure 3(a), it introduces virtual human which can communicate with users through voice, and show its own emotion [21]. As shown in Figure 3(b), Blumberg, et al. implement synthetic characters that show reactions according to their own emotion and desire [22, 23]. Figure 3(c) presents virtual animal training system which makes users experience animal training with their hands [24]. In Figure 3(d), it shows immersive fencing game which allows users to play game with a virtual fencer through their voice and the movement of sword [25]. These works are focused on generating autonomous responses of virtual characters. However, they only allow to interact with users at installed places, and do not consider users' characteristics. Therefore, they only support limited interaction with users and virtual characters.

(a) Virtual Human [21]

(b) Synthetic characters [22]

(c) Virtual animal training [24]



(d) Immersive fencing [25]

Figure 3. Application with virtual characters

Moreover, researches on personalized contents have progressed in various areas. Virtual Personal Service Assistants offer personalized interface according to users' preference, and then let users exploit contents naturally [26]. Figure 4(a) shows virtual unju temple as personalized virtual heritage system which makes users undergo storytelling system suitable for their experience, preference, etc [27, 28]. In Figure 4(b), it introduces vrFlora which autonomously react to users' interaction with actual plants [29]. However, these works are focused on realism based on the sense of sight, and do not allows users to move the contents to other places. Moreover, even though they try to the personalization of contents, they do not show the high degree of personalization which makes users share their emotional state with the contents.

(a) virtual unju temple [27, 28] (b) vrFlora [29]

Figure 4. researches on personalized contents

Figure 5 shows analysis result of related works compared with characteristics of proposed u-Contents, i.e., u-Realism, u-Mobility, and u-Intelligence. Though current works offers multimodal feedback based on the sight, hearing, and tactual sense, they do not support enough realism to satisfy the five senses. In addition, they consider the mobility about contents based on the sight and hearing. However, they do not allow users to move the contents to any devices in the environments, and to share the contents with others in shared space. Moreover, there are several researches which enable to interact users with contents, and offer personalized contents according to users. However, they do not reflect users' emotional state and provide autonomous contents suitable for the state.

IV. APPLICATIONS

If we apply u-Contents into ubiquitous smart space, we can expect several changes in our daily life. Users can exploit the realistic contents offering multimodal feedback suitable for the environments through any devices. In addition, they can augment or add selective contents onto displayed contents. Moreover, they can freely move the displayed contents from devices in environments to their own mobile device. They also can share the contents, and collaborate through the contents with others. Furthermore, users can experience different contents proper to their own experience, attention, intention. In private space, the offered contents present affective response by reflecting users' stress and emotion. Therefore, it enables to present affective sympathy with users as if human beings sympathize with others. Figure 6 shows possible scenario when we apply u-Contents into future smart home environments.

Figure 6. Possible application for smart home environments

There are father, mother, and a sun in the living room. They are watching TV program which reproduces Japanese invasion of Korea in 1592. Father suddenly recollects memories which he traveled Hansando with his family. And he moves contents at TV to smart window, which displays photo-realistic contents with the high quality of realism, through his mobile device. Then, the contents which look like actual offshore of Hansando are displayed on smart window, and the blooming of the sea pours out. Then virtual turtle ship appears on smart window. When father moves the contents to smart table which makes users interact with realistic contents, the contents on the table shows scenes as if users watch the sea and turtle ship at the sky. Displayed turtle ship moves slowly. Moreover, each member shows different contents with his

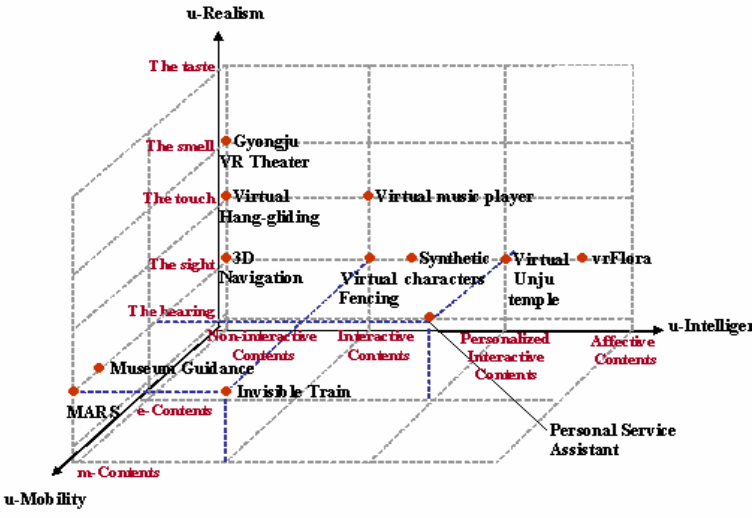


Figure 5. The analysis results of related works

or her mobile device according to preference, attention, etc. When a sun waves his hand on the table, the speed of virtual ship adjusts according to movement of his hand. Because of the response, the sun becomes happy, and repeatedly moves his hand. Moreover, the sun's happiness is reflected to contents on the table. Then, the displayed contents are gradually changed to the scene at fine day. Finally, the sun's interest about the contents increases, and then his face is also changed to be simile. Furthermore, his father and mother also become happy since the sun's smile.

According to above scenario, it makes users experience new kinds of realistic contents in smart home environments through u-Realism, u-Mobility, and u-Intelligence. Each person freely moves contents to smart objects, e.g., smart window or smart table, etc, in home through his or her individual mobile device. And transferred contents are augmented on the objects differently according to characteristics. In above scenario, same contents indicating Hansando differently are displayed. That, the contents are shown as like the actual map on the smart table, and are displayed looks like offshore of Hansando on the smart window. Moreover, the contents are also displayed differently on individual mobile device according to each person's context, e.g., attention, experience, etc. They also evoke users' interest through natural interaction, e.g., in above scenario, the speed of the turtle ship is adjusted according to the movement of sun's hand. Furthermore, the interaction with users induces users' emotional state, and then the state is also reflected to the reaction of contents. Finally, it makes users sympathize emotionally with contents.

V. CONCLUSION

We presented u-Contents which provide new kinds of realism suitable for users in ubiquitous smart space. The u-Contents improved realism based on personalized multimodal feedback with u-Realism. They allowed users to share the contents with others through u-Mobility. Moreover, they evoked users' interest through personalized response suitable for users' experience, preference, emotion, etc, based on u-Intelligence. Furthermore, the u-Contents sympathize with users through autonomous reaction to users' emotional state. In order to realize the proposed u-Contents, we analyzed researches related to develop realistic contents. Then, we described future direction of essential researches. We also presented possible scenario by applying the proposed u-Contents to smart home environments. Therefore, the u-Contents showed potentials as new kinds of realistic contents proper to ubiquitous smart space.

In order to concretely realize u-Contents, there are several challenges. Firstly, it allows users to augment contents suitable for users' context. Secondly, it must develop interaction methods for supporting collaboration with users. Thirdly, in order to develop affective contents, it should develop affective agent to understand users' emotion and present its own emotion through autonomous reaction.

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