u-Contents: Describing Contents in an Emerging Ubiquitous Virtual Reality *

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Abstract

We define u-Contents, multi-media contents which are used in a new environment where ubiquitous computing meets mixed reality, and its descriptor. Most of research in ubiquitous computing and mixed reality fields were about developing core infrastructures or fundamental algorithms. In this paper, we focus on the behaviors and properties of contents rather than infrastructures or algorithms. We introduce three conceptual key properties; u-Realism, u-Intelligence and u-Mobility. Additionally, the relationships among those properties also are shown. Based on these relationships, we discuss the usefulness of the descriptor in our future applications. And also, a simple application scenario using the defined u-Contents descriptor is shown.

1. Introduction

Recently Internet access is almost available everywhere and small computing devices such as cell phones or Ultra Mobile Personal Computers (UMPCs) have more and more computing powers with wireless communication capabilities. As a result, a computing paradigm has been shifted toward Ubiquitous Computing (ubiComp) according to the considerable developments on both Internet infrastructures and computing hardwares. In the sense, M.Weiser's vision, where computing resources are invisibly distributed anywhere at anytime [13], is coming in our everyday lives.

According to the paradigm shifting, the contents consumed in our lives are also going to have significant changes. There have been working groups of multimedia, such as MPEG-7, MPEG-21, and MPEG-V, to reflect these changes of computing environments to contents. And also, S. Oh *et al.* [12] and K. Kim *et al.* [7] explained the new concept on contents for ubiComp. I. Barakonyi and D. Schmalstieg [2] proposed intelligent agents for Augmented Reality (AR) with consideration of ubiComp environments. However, there are still ambiguous issues how to relate contexts to contents in practical applications.

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In this paper, we discuss the properties and descriptor of u-Contents used in a new environment where ubiComp meets mixed reality. We review u-Contents definition and introduce three key properties; u-Realism, u-Intelligence and u-Mobility. And also we show the relationships among three of them. Based on the relationship, we discuss the descriptor which would be useful in Ubiquitous VR applications. At the end, we show a preliminary system we implemented based on the described concept.

2. u-Contents Definition and Property

2.1 Definition

We define u-Contents as multimedia contents used in Ubiquitous Virtual Reality. Simply u-Contents can be described as ubiComp-enabled contents. In particular, u-Contents realistically mediate real space, intelligently respond to user-centric contexts, and seamlessly migrate within selected entities. The terminologies we used for u-Contents definition are following:

- **Ubiquitous Virtual Reality (U-VR)**: an emerging environment where *a collaborative wearable context-aware mediated reality* is realized [10].
- **Mediated Reality**: an environment where not only can visual material be added to augment real world experience, but reality may also be diminished or otherwise altered if desired [11].
- **User-centric Context**: user-centric information among a variety of contexts in service environments that is interpreted, in terms of **5W1H** (who, when, where, what, how, why), by applications [5].
- **Selected Entity**: closely related entities in one community. We follow A. Dey's definition [4], which the entity can be any person, place or object.

2.2 u-Contents property

We elaborate three key properties of u-Contents; u-Realism, u-Intelligence, and u-Mobility.

u-Realism is a realistic mediation that adds virtual contents or removes real entities in real space by reflecting users' and environmental contexts. u-Realistic contents

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are seamlessly registered with a physical space in terms of users' five senses. In particular, the visual sense is the most important one for seamless registration rather than tactile or auditory senses. Let us consider visual registrations of contents. The visual registration is to overlay the virtual contents onto the real image. However, the image formation pipelines of the virtual contents and the real images are different so that this difference reduces the contents realism. In the sense, enhancing u-Realism is reducing the differences between the augmented content(s) and the real scene. There have been research on this issue recently. For example, G. Klein and D. Murray [8] proposed a method which simulates each image formation step to reduce visual differences of real images and virtual contents. As well as matching different resolution between two different contents, we also need to consider the calibration and tracking techniques for seamless registration of the contents. We have three steps to achieve u-Realism according to the different levels of context reflected to the contents. **Stage 1**: Contents do not include any context information. **Stage 2**: Contents reflect the environmental contexts where contents are registered. **Stage 3**: Contents reflect not only users' contexts, but also the environmental contexts.

u-Intelligence is the property that contents respond to situational information with respect to a user and change representations according to a user's explicit interaction and implicit states, such as, intention, attention, and emotion [3]. The goal of using u-Intelligent is to offer users better experience by providing the personalized, responsible content(s) in their everyday lives. Thus, we divide stages based on the level of personalized responsiveness of contents as followings. **Stage 1**: Contents respond to users' interactions regardless of their contextual information. **Stage 2**: Contents customize the responses and representations according to users' contexts, such as location, etc. **Stage 3**: Contents share users' implicit contexts, e.g., intention, emotion with the users. To achieve key characteristics of u-Intelligent contents, we describe core technologies with current researches. Basically, the contents should have the ability to change the responses and representation in an autonomous way. We need context-awareness for making contents reflect user's contexts. To make users interact with the intelligent contents, the contents should perceive the users' interactions and respond to the interactions.

u-Mobility is the property that contents move among selected entities. u-Mobile contents have information that freely move themselves among persons, devices, or places [9]. Transmitted and translated contents by u-Mobility characteristics can move freely to closed related entities and adapt to circumstance (VR or Real) of the entity. Due to higher network bandwidth, the movement of u-Contents is much freer in ubiComp enabled environment than before. We list up some key issues especially where the content moves. We classify the steps by level of u-Mobility enabled. **Stage 1**: Stand-alone contents reside only in a user's device. The contents of the device are used for augmentation without sharing them. **Stage 2**: the device can download contents from pre-defined contents providers such as content servers. In other words, it can provide a user with not only own contents but also downloaded contents from predetermined providers. **Stage 3**: Contents are shared in related entities, or community members. Contents of the third stage reside in anywhere at anytime, due to enabled ubiComp. The path of movements of contents, called self-configurable contents, is dynamically determined.

3. u-Contents Descriptor

In context-aware applications, it is important to formulate a context in a consistent way. For this purpose, S. Jang et al. [6] suggested the unified context application model 5W1H (who, when, where, what, how, why). The proposed descriptor is designed to include not only general meta data of a context, but also each u-Contents property information according to 5W1H. It allows U-VR applications to make use of users' and environmental contexts in their main process, directly or indirectly.

3.1 Descriptor Format

A u-Contents descriptor is a header of a u-Content in the form of meta data. The descriptor defines characteristics of the followed contents (multimedia) data. XML is used for the parsing process. Note that u-Contents descriptors should be written from the viewpoint of contents, not application viewpoint. Each field has information as shown in Table 1.

Table 1. u-Contents descriptor format

Field	Description
Who	the author (owner) of the contents
When	the last creation or modification time
Where	the position of the contents in a local or a global coordinates
What	Parameters for u-Contents properties: [u-Realism, u-Intelligence, u-Mobility]
How	the information about type of authoring tools or context-aware toolkits involved with all fields
Why	the lastly inferred results obtained from a certain context-aware toolkit

We suggest two attribute types in **[What]** field. One is static type and the other is dynamic type. While the static attributes are not changeable whenever the u-Contents is passed to context-aware modules for processing, the dynamic attributes can be overridden by being fused with external contexts. We rely on this simple criteria to start to classify and group characteristics of u-Contents. Details are described in Table 2.

3.2 Descriptor in CART

The framework Context-aware Augmented Reality Toolkit (CART) is explained to show validity of the proposed descriptor. Simply, CART encodes and decodes u-Contents for U-VR applications. Figure 1 shows the overall flow that exploits u-Content as one input of CART. CART allows developers to easily fuse AR and context-aware technologies for U-VR applications. It consists of a context-aware module and an augmentation-enabled module. In practice, CART can be implemented by combinations of existing toolkits in each area. For example, the context-aware module can be Unified Context-aware Application Model (UCAM) and the augmentation-enabled module can be osgART [1], respectively. We focus on the flow of u-Contents in CART. When the u-Contents is delivered to CART, the u-Contents descriptor (D) is separated from its body. Then, the descriptor is sent to UCAM to being integrated with all contexts from other services or sensors in the environments. The descriptor is overwritten or filled out during this step. After the integration, the modified descriptor (*f-context*) is sent to each property managers. u-Realims manager extracts the defined information from the f-context and transforms them to rendering parameters. Especially, u-Intelligence manager determines responses. u-Moblity manager directly receives contexts from sensors since it is related to low level processing such as parameters for tracker module.

4. Scenario & Implementation

We show an example related to the proposed concept though it is not perfectly implemented as an ideal u-Content.

4.1 Simple Avatar Scenario

Basically, the avatar lives in a home. The avatar is looking for a warm and silent place to take a rest. If the avatar finds the good place, he/she moves toward the place. There are four sensors and services in the room. And the contexts generated from these sensors are not pre-defined.

4.2 Implementation

The avatar co-exists in both the virtual room and the corresponding real room. First of all, it is required to align each coordinates of the real and virtual environment so that the system interprets the positions of each sensors, services, and the avatar. We utilized the interactive method in align two coordinates by selecting known 3D points since we assumed that the virtual room was modeled as the real room accurately. In the system, a real-time marker-less AR tracker was used with OpenSceneGraph to augment the avatar seamlessly. The registered avatar gets the information from the distributed sensors and services. Then, the information is encapsulated as 5W1H form and sent to the context-aware toolkit in CART (We used UCAM for this purpose). Those sensory information are inferred and used in the CART. For instance, the light information from the lamp such as on/off, intensity, color, and position can be used to generate virtual shadows related to u-Realism. And the avatar actions are determined and activated. Figure 2 shows a snapshot of the avatar in the current system.

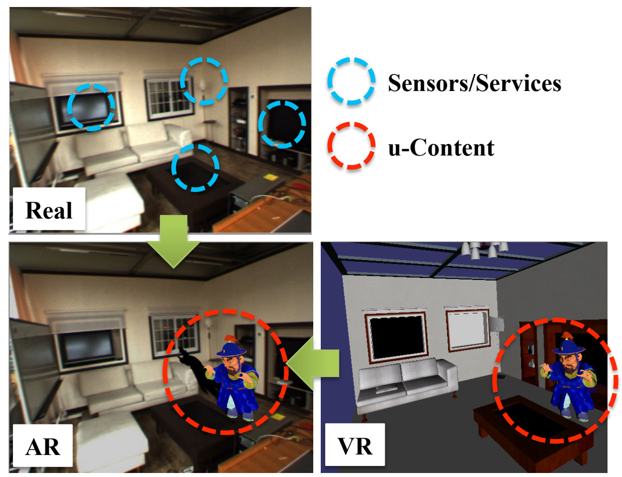

Figure 2. u-Contents example

5. Conclusions

We presented a new concept about contents in ubiquitous virtual reality. u-Contents were defined with three key properties; u-Realism, u-Intelligence and u-Mobility. In addition, the descriptor of u-Cotents was proposed with its application platform CART. Finally, the avatar example was introduced. The proposed concept and descriptor of u-Content will allow developers to design and implement U-VR applications in various domains. As remained work, more concrete and sophisticated descriptor is going to be discussed with real parameters from many applications.

References

[1] www.osgart.org.

[2] I. Barakonyi and D. Schmalstieg. Augmented reality agents for user interface adaptation. *Comput. Animat. Virtual Worlds*, 19(1):23–35, 2008.

[3] S.-B. Cho, K.-J. Kim, K. S. Hwang, and I.-J. Song;. Anidiary: Daily cartoon-style diary exploits bayesian networks. *Pervasive Computing, IEEE*, 6(3):66 – 75, Jul 2007.

Table 2. Description of [What] field.

Property	Static Attributes	Dynamic Attributes
u-Realism	**Quantitive information of contents body**: e.g, size or dimension of data, total mesh numbers, etc. **Additional information for 5 senses representation**: Data in the order from sight, hearing, touch, smell, and taste.	**Contexts history of contents body**: the pre-contexts are kept for other applications. **Environmental information**: e.g. light source positions, temperature, intensity of illumination, etc.
u-Intelligence	**Quantitative information**: e.g. the list of possible responses, etc. **Additional information for intelligent response**: e.g. the list of autonomy control rules based on content-specific information.	**User-specific information**: e.g. user-specific logics **Environmental information**: e.g., a user location, profile, etc.
u-Mobility	**Privilege of u-Contents**: the ownership of u-Contents and privilege of entities which share it. the level of disclosure and permitted modification. **Requirement for Movement**: the properties of a target entity e.g. minimum bandwidth of network, supported protocols, etc.	**Community Information**: the community metadata is described, for instance, the members, the goal of the community and relations among the entities. **Movement Log Information**: the movement information is kept for understanding usage of the u-Contents.

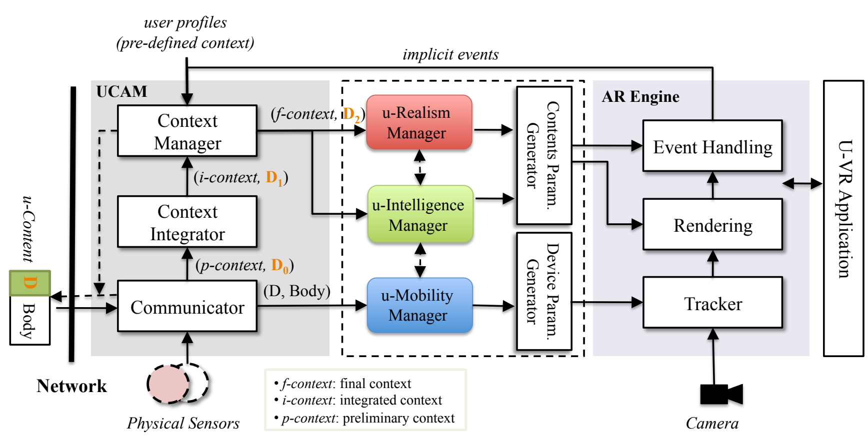

Figure 1. Flow of u-Contents in Context-aware Augmented Reality Toolkit

[4] A. Dey. Understanding and using context. *Personal and Ubiquitous Computing*, 5(1), Jan 2001.

[5] D. Hong, H. R. Schmidtke, and W. Woo. Linking context modelling and contextual reasoning. *The 4th International Workshop on Modeling and Reasoning in Context (MRC)*, pages 37 – 48, 2007.

[6] S. Jang and W. Woo. Ubi-ucam: A unified context-aware application model. *LECTURE NOTES IN COMPUTER SCIENCE*, Jan 2003.

[7] K. Kim, D. Hong, Y. Lee, and W. Woo. Realization of u-contents: u-realism, u-mobility and u-intelligence. *International Symposium on Ubiquitous VR*, Jan 2007.

[8] G. Klein and D. Murray. Compositing for small cameras. *Mixed and Augmented Reality, 2008. ISMAR 2008. 7th IEEE/ACM International Symposium on*, pages 57 – 60, Aug 2008.

[9] M. Kumar, B. Shirazi, S. Das, B. Sung, and D. Levine. Pico: A middleware framework for pervasive computing. *IEEE PERVASIVE COMPUTING*, Jan 2003.

[10] Y. Lee, S. Oh, C. Shin, and W. Woo;. Recent trends in ubiquitous virtual reality. *Ubiquitous Virtual Reality, 2008. ISUVR 2008. International Symposium on*, pages 33 – 36, Jun 2008.

[11] S. Mann. An historical account of the 'wearcomp' and 'wearcam' inventions developed for applications in 'personal imaging'. *Wearable Computers, 1997. Digest of Papers., First International Symposium on*, pages 66 – 73, Sep 1997.

[12] S. Oh, W. Lee, Y. Park, and W. Woo. u-contents: Realistic and affective contents in ubiquitous smart space. *International Symposium on Ubiquitous VR*, Jan 2006.

[13] M. Weiser. The computer for the 21 stcentury. *ACM SIGMOBILE Mobile Computing and Communications Review*, Jan 1999.