CAMAR Tag Framework: Context-Aware Mobile Augmented Reality Tag Framework for Dual-reality Linkage

Hyejin Kim, Wonwoo Lee, and Woontack Woo
GIST U-VR Lab.
500-712 Gwangju, S. Korea
{hjinkim, wlee, wwoo}@gist.ac.kr

Abstract

In this paper, we propose a novel tag framework for sharing information in a dual-reality space, which is based on Context-Aware Mobile Augmented Reality (CAMAR). When a user selects a target object to be tagged onto a dual-reality, the proposed framework and procedures create a CAMAR Tag to be registered in a virtual space with a user's mobile device. CAMAR plays multiples roles as a reference point, a sharing point and a key of contextual searching. We present a concept behind CAMAR Tag and describe how it can be generated, implemented and deployed in a dual-reality.

1. Introduction

There has been a renewal of interest in dual-reality [1] linkage in Ubiquitous Virtual Reality (U-VR) [2]. Dual-reality linkage which connects information organically in the real world and a virtual world makes it possible to use information of virtual world in the real world, and vice versa. Therefore, it helps complement information of one world to the other. A user needs to exploit this information intuitively, and Augmented Reality (AR) technology is a method that can support it. To do this, the problem we have to consider is setting up of a reference point so it can be used interchangeably in both worlds.

Several studies looked on linkage between the real world and a virtual world with different approaches. Oh et al. [3] and Smith [4] focused on how to seamlessly manipulate objects in the real and a virtual world. To do this, [3] proposed U-VR Simulator, which monitors and simulates objects in the real and a virtual world using context-awareness. However, they do not support visual registration using AR in dual-reality. [4] introduced the dual-reality object, which can live in the real world or a virtual world and freely moves between the both worlds. However, this object is limited to a specific object like a disk containing RFID tag and the object does not exist in both worlds at the same time. Therefore, it is necessary to make a use of an arbitrary object for connecting between the real and a virtual world.

Henze et al. [5] proposed a physical-virtual linkage system using contextual bookmarks, which are produced by end-users to capture information of interest using a mobile device. However, they lack a connecting mechanism between two worlds because they do not consider a virtual world and provide a link to information related to only physical object. Bouvin et al. [6] proposed a framework, which provides a virtual hypermedia according to the real context information. However, it supports one-way access which retrieves information in one world according to the other world. In dual-reality, however, it is necessary to support two-way access between the object and its virtual counterpart.

Therefore, in this paper we propose a novel tag framework, which registers a target object of the real world as a reference point to a corresponding object of a virtual world and manages registered target objects in the virtual world. In this process, we define Context-Aware Mobile Augmented Reality Tag (CAMAR Tag) as the reference point which is a set of contexts used to register a target object to the virtual world. CAMAR Tag framework is designed for supporting visual registration using AR, making an arbitrary object a reference point in dual-reality, management of contents based on space information and two-way access between the real and the virtual world.

2. Context-Aware Mobile Augmented Reality Tag

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2.1. Definition

CAMAR stands for Context-Aware Mobile Augmented Reality which combines context-awareness and mobile AR [7]. CAMAR Tag is a novel tag concept which adds a tag to an object as a reference point in dual-reality to mark shared information. To register a reference point in dual-reality, CAMAR Tag for a target object is generated on a mobile device of a user in the real world and stored in the virtual world. The registered CAMAR Tag is also used to recognize and track a target object for authoring and viewing contents in the real world. That is, CAMAR Tag is a tag data model composed of *a model context* of a target object, *an environment context* about when or where it is generated, *a user context* and *a contents context* authored by a user as shown in Table 1.

Specifically, a *model context* is a context related to a target object such as global coordinate, local coordinate, scale, pose matrix, information for model (3D points, 3D lines, etc.), and information for recognition (feature points, edges, textures, etc.). Different information for recognition can be indexed and managed according to time and light information of when the CAMAR Tag is generated. *An environment context* is a context related to the environment such as location, direction, light and time, which is obtained when CAMAR Tag is generated. Also, *a user context* is a context related to users such as an owner, a community to share and a keyword for intention. This information is fundamental for authoring of contents. Finally, *a contents context* is a context related to various contents such as text, 2D and 3D contents, audio and video.

Table 1. CAMAR Tag data model

	Attributes		Examples
Model Context	Global Coordinate		CAMAR Tag ID
	Local Coordinate		X: (100, 0, 0), Y: (0, 100, 0), Z: (0, 0, 100)
	Scale		X: 1000, Y: 500, Z: 300
	Pose Matrix		{-0.005856, 0.010862, 0.029240, -692.08514, …… , 0.000000, 0.000000, 0.000000, 0.1000000}
	For Model	3D Points	N: 8, (100, 10, 40) (200, 10, 40) … (500, 20, 30)
		3D Lines	N: 12, (P1, P2) (P2, P3) … (P11, P12)
		Reserved Info.	For Extension
	For Recognition	Feature Points	SIFT Descriptors, or…
		Edges	Edge Descriptors
		Textures	N: 8, S: 256 256 3
			(100, 10, 255, …) … (255, 0, 200, …)
		Reserved Info.	For Extension
Environment Context	Location		(100, 200)
	Direction		60
	Light		Medium
	Time		2009:03:01:13:00
	Reserved Info.		For Extension
User Context	Owner		Hyejin Kim
	Community		GIST U-VR Lab.
	Keywords		Social event
	Reserved Info.		For Extension
Contents Context	Text		“Happy birthday to you”
	Audio		http://uvr.gist.ac.kr/music/Happysong.mp3
	Video		None
	2D and 3D Contents		http://uvr.gist.ac.kr/3DContents/Cake.3ds
	Reserved Info.		For Extension

2.2. Use-case

In this section, we describe conceptual steps to make CAMAR Tag for the authored contents on a target object in the real world and to reflect it in the virtual world. There are two cases: the former is when an object already exists in the both worlds as shown in Figure 1(a) and the latter is when an object exists only in the real world as shown in Figure 1(b). In the former case, we need to match global coordinate of the real world and that of the virtual world, which are common bases in dual-reality to transfer some information as in the first step in Figure 1(a). Then, we can generate local coordinates of a target object and author contents on the object as in the second step in Figure 1(a). In the process, we also can get transformation between global and local coordinates. Therefore, we are able to register contents based on local coordinates in the virtual world using the corresponding transformation in the third step in Figure 1(a). In the latter case, first and second steps are the same with that of the former case. Then, we are able to register 3D model and contents based on global coordinate in the virtual world in the third step in Figure 1(b).

CAMAR Tag plays multiple roles as a reference point, a sharing point and a key of contextual indexing as follows because it exists in the both worlds as shown in Figure 1. Firstly, CAMAR Tag of a target object is stored in the virtual world having space structure information and is used as a reference point to recognize and track objects in AR view. Therefore, it is possible to augment contents on other objects without additional recognition and tracking if the objects are related to a target object. Also, if the virtual world is shared commonly and a user makes and registers contents augmented on a target object by generating CAMAR Tag, others can also access the contents by only sharing the virtual world. Finally, if a context included in CAMAR Tag is used as a key for

contextual indexing which searches for a specific attribute of a context in the virtual world, contents context or model context can be varied according to a value of the context attribute.

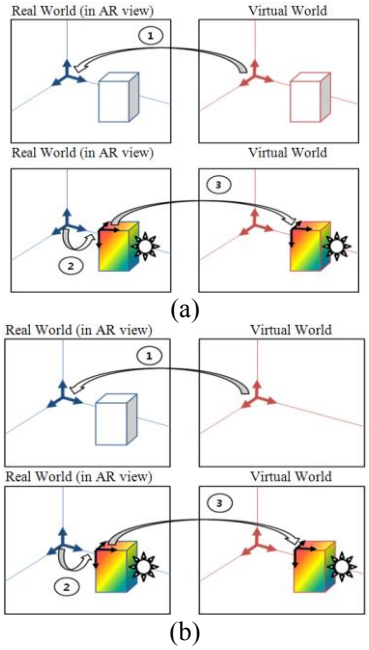

Figure 1. The conceptual steps to make CAMAR Tag: (a) when an object already exists in both worlds (b) when an object exists only in the real world

3. CAMAR Tag Framework and Procedures

Figure 2 shows the conceptual framework for CAMAR Tag, which includes three main components. *Mobile device* is a device such as laptop, UMPC, PDA and smart phone. It can be used to register CAMAR Tag and view contents created and modified in both worlds. *Real world* is a real environment that includes target objects which can be CAMAR Tag. *Virtual world server* is a networked server which is responsible for registering CAMAR Tag to corresponding virtual world model and retrieving its list using contextual indexing. Interaction for global and local coordinate registration is processed between *mobile device* and the *real world*. Also, CAMAR Tag list requests, retrievals and CAMAR Tag registration are performed between *mobile device* and the *virtual world server*.

For registering CAMAR Tag, *mobile device* is composed of several modules: sensor data acquisition, CAMAR Tag list update according to sensor values, global and local coordinate registration, content authoring, and CAMAR Tag generation. First of all, *mobile device* obtains environment context surrounding a user such as location, direction, etc. Then, it brings the model of the virtual world according to current view using CAMAR Tag update from the *virtual world server* and performs global coordinate registration with the real world image. After that, it sets up local coordinate of an interested target object and gets the relationship between two coordinates. In the process, it collects features to be exploited in recognition and tracking of the object as well as coordinate information, which is a model context. Finally, *mobile device* generates CAMAR Tag containing user and contents context through content authoring and registers it to the *virtual world server*. Then the *virtual world server* receives CAMAR Tag registration request and adds the tag as a node to proper position of the virtual world model by referring coordinate information of model context.

For viewing contents in AR view, *mobile device* is also comprised of several modules: sensor data acquisition, CAMAR Tag list update according to sensor values, ROI selection, CAMAR Tag recognition and tracking and contents augmentation. *Mobile device* conducts CAMAR Tag update using environment and user context as we mentioned before. In other words, *virtual world server* retrieves CAMAR Tag list by contextual indexing using environment context as a key. Then, *mobile device* recognizes and tracks a target object by using features of model context in CAMAR Tag, which is stored during registering and augmenting contents context to a target object.

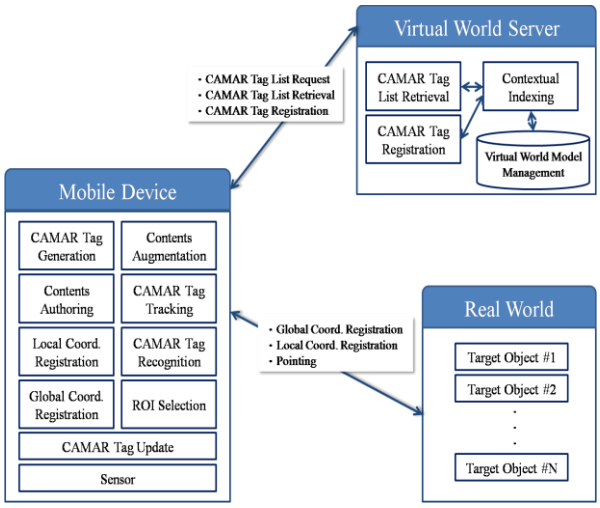

Figure 2. Conceptual framework for CAMAR Tag usage

4. Prototype

In this section, we show a prototype of registration of CAMAR Tag. First of all, we assume that a TV object is already registered as CAMAR Tag in virtual world and mobile device brings a corresponding view of virtual world model from virtual world server according to environment context which is obtained through sensors. Then, we can perform global coordinate registration between the real and the virtual world view by recognizing and tracking the TV object as in Figure 3. After that, a user wants to add some contents such as a teapot on a table and shares it with others. To do this, we select vertices of table shape in two images and conduct 3D reconstruction as shown in Figure 4. Then, we can generate local coordinates based on the table's first vertex and model context including coordinate information and features. Now a user adds virtual contents and the generated contexts is saved as an XML. Figure 5 shows that generated CAMAR Tag information is reflected on the virtual world.

5. Conclusion

In this paper, we have defined CAMAR Tag as a reference point which is a set of contexts used to register a target object to the virtual world. And we presented CAMAR Tag framework, which registers a target object of the real world as a reference point to a corresponding object of the virtual world and manages registered target objects in the virtual world. CAMAR Tag plays multiple roles as a sharing point and a key of contextual search as well as a reference point and supports various functions according to the role. Currently, our prototype is implemented on UMPC and has some assumption and practical issues in performing global coordinate registration and managing CAMAR Tag systemically. In the future work, we will implement this concept on mobile phone and analyze how to select specific regions or features of camera image even if display of mobile phone is small.

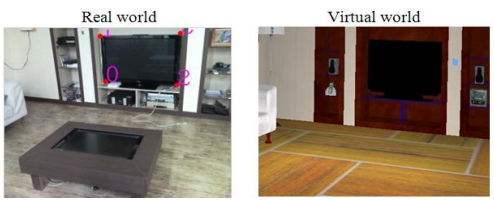

Figure 3. Global coordinate registration

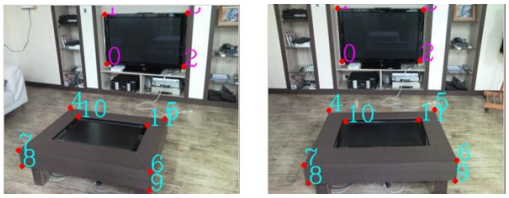

Figure 4. Local coordinate generation

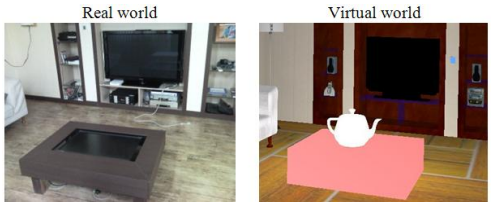

Figure 5. Reflection of CAMAR Tag to virtual world

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References

[1] J. Lifton, "Dual Reality: An Emerging Medium," Ph.D dissertation, Massachusetts Institute of Technology, Dept. Media Arts and Sciences, 2007.

[2] Y. Lee, S. Oh, C. Shin, and W. Woo, "Ubiquitous Virtual Reality and Its Key Dimension," in *Proc. of IWUVR'09,* 2009, pp. 5-8.

[3] Y. Oh, C. Kang, and W. Woo, "U-VR Simulator Linking Real and Virtual Environments based on Context-Awareness," in *Proc. of IWUVR'09*, 2009, pp. 52-55.

[4] R. B. Smith, "Dual-Reality Objects," *The Human Computer Interaction Consortium 2004 Winter Workshop, 2004. Available in http://www.ics.uci.edu/~redmiles/ics227-SQ04/papers/OffTheDesktop/Smith.pdf.*

[5] N. Henze, E. Rukzio, A. Lorenz, X. Righetti, S. Boll, "Physical-virtual linkage with contextual bookmarks," in *Proc. of MobileHCI'08*, 2008, pp. 523-526.

[6] N. Bouvin, B. Christernsen, K. Grønbæk, and F. Hansen, "HyCon: a framework for context-aware mobile hypermedia," *Hypermedia*, vol. 9, no. 1, pp. 59-88, 2003..

[7] S. Oh and W. Woo, "CAMAR: Context-aware Mobile Augmented Reality in Smart Space," in *Proc. of IWUVR'09*, 2009, pp. 48-51.