CAMAR Mashup: Empowering End-user Participation in U-VR Environment

Hyoseok Yoon, Woontack Woo
GIST U-VR Lab.
500-712 Gwangju, S. Korea
{hyoon,wwoo}@gist.ac.kr

Abstract

In this paper, we propose a concept of Context Aware Mobile AR (CAMAR) mashup as an enriched form of participatory user interaction in U-VR environment. We define CAMAR mashup and discuss how its characteristics are different and distinguishable from previous mashup activities in various additional aspects such as context-awareness, mobility and presentation. To elaborate the proposed concept, an exemplar scenario is presented and foreseeable technical challenges are discussed. [1]

1. Introduction

In Ubiquitous Virtual Reality (U-VR) environment where VR seamlessly intertwines with ubiquitous computing enabled facilities in the real world, a new user interaction paradigm of pro-sumer is required [1]. Many ideas and concepts surrounding infrastructure framework, services and content are flourishing lately, but little has been researched about the roles and specific interactions of users in U-VR environment. Users are no longer mere recipients of closed services, rather they actively engage in changing the environment surrounding them. Accordingly, more responsibilities are granted to end-users to form "cultures of participation" through end-user development and meta-design activity [2].

User interaction or participation in an active manner is critical to success of many real world applications. Supporting examples are easily witnessed with Web 2.0 [3] vision of the next generation of Web as software platform and successful Web sites such as Google Maps, Flickr and YouTube which emphasize active user participations operated on openness and sharing. Today, vast amounts of user generated content are publicly made available, shared among an interested group and combined as user-customized services. Also a new form of public authoring [4] is investigated to satisfy users' multiple roles as authors and consumers of media under an enjoyable experience.

In U-VR environment, we acknowledge and appreciate the importance of the user participation, namely in a form of "mashup" [5]. In this paper, we propose mashup as a tool for empowering user participation, especially for Context Aware Mobile AR (CAMAR) [6] users, which we call CAMAR mashup. We first discuss previous mashup activities. Then we elaborate similar and different characteristics of CAMAR mashup in terms of context-awareness, mobility and presentation. Furthermore we present an exemplar scenario and discuss on foreseeable technical challenges.

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2. Related Work

There have been much activities and studies with the term "Web mashup" for combining of data and functions from different Web services. Yu et al. summarized and categorized characteristics of Web mashup tools by employed mashup paradigm and software instruments [5].

Recently the term "mashup" is used beyond Web. Hartmann et al. came up with an idea to combine Web mashup with everyday artifacts, offshelf software and hardware hacks to form ubicomp mashups [7]. In sensor level, Maekawa et al. presented a system [8] that personified sensor-attached objects to produce a report or Weblog showing user interaction history. Angus et al. discuss on benefits and potential of public authoring in urban settings [4], which can be viewed as a form of mashup. Similarly, Tuulos et al. explored a large scale mashup [9] where large public screens, stories from Web and user interaction with mobile phone are combined to provide a gaming experience to users.

In presentation of a mashup service, traditional Web-based presentation is preferred in the beginning, but now a different form of visualization is pursued. Image Geo Mashup [10] and Vidente [11] realized augmented reality (AR) view to render and display secondary and additional information such as weather information and geographic data models from GIS server.

Another movement is taking place in shifting of platform from a typical desktop platform to a mobile platform as exhibited in [4] [9] [11] [12].

3. CAMAR Mashup

In this section we define CAMAR mashup and explain its characteristics. Then we compare CAMAR mashup with other mashup concepts, such as classical Web mashup and ubicomp mashup [7].

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3.1. Definition

*CAMAR mashup is **in situ mobile user interaction** for the purpose of seamlessly combining context*[2] *to and from **mashup targets** using a **CAMAR device** to create **evolvable mashup results** where mashup process is enhanced with **context awareness** and **augmented reality** is mainly used to visualize mashup workspace and mashup results.*

3.2. Characteristics

- ***In Situ* Mobile User Interaction.** User interaction should be locally bounded for where the user is and for selecting the resources and capabilities of mashup on the move. For example, a user in the first floor of the building can mashup resources and functionalities acquired in the first floor but disallowed from directly accessing resources of a room in the next building. The user would be able to access resources in the next building when he is actually in the place. The granularity of location and place may vary, but in CAMAR mashup, an effective mashup area is determined by the location of a CAMAR device user and its camera view.
- **Mashup Targets.** Unlike Web mashup where primary mashup targets are Web services, CAMAR mashup targets are sensors, physical/logical actuators, services and user-defined spatial tags in the real world. Sensors produce real time and low-level contextual readings which we can learn from the environment. Services and user-defined tags produce user interaction related contexts which help understand user behaviors. These targets generally have visual and physical presence where users can actually see and touch. Thus CAMAR mashup enables users to directly add additional context from different mashup targets to another to better use context of the local environment and users. For logical and invisible services also, users are able to discover and manipulate such targets by resource detection followed by visual representation on a CAMAR device.
- **CAMAR Device.** CAMAR device is a mobile computation unit equipped with a camera for real world view, touch screen device for interaction, location tracking through GPS or other means of localization, wireless connection and processing power for mashup processes. Newer mobile phones and smart phones are good CAMAR device candidates since they support the aforementioned features including high processing power.
- **Evolvable Mashup Result.** The result of CAMAR mashup is evolvable meaning that the previous mashup results are incrementally added and manipulated by participation of other users to enrich the information it embraces. The mashup results are stored in an equivalent mashup target in the virtual world and retrieved for next iterations of mashup. For example, activities such as adding more information to mashup targets and correcting wrong information both contribute to increase the value of the mashup results.
- **Context-awareness.** Mobile workspace is physically limited with small screen size and we cannot expect a large and wide screen found in a desktop environment. To deal with this limitation, context-awareness virtually and effectively enlarges mobile workspace according to given context. For example, in mobile workspace we do not care for luxurious and auxiliary options and details. Rather we focus on a simple and intuitive interaction metaphor that deals with a single item, or at best a couple of items at a time. In this process, context-awareness can help reduce a number of unnecessary and unrelated resources by filtering and suggesting which components are mashup-compatible by organizing and grouping.
- **Augmented Reality.** Augmented reality is an effective multi-modal technique to augment information in on-site context. Closely coupled with the first characteristic, augmented reality especially helps user to visually and accurately deal with mashup targets by direct identification and mapping. Augmented reality also enhances and enriches realistic user experience through sound and tactile feedback augmentation.

3.3. Comparison

Table 1 shows a comparison summary of different mashup concepts. Classical Web Mashup[3] (WM) can be characterized by composing a new mashup Web service through developer-oriented APIs where Web is used as presentation and development platform. Ubicomp Mashup (UM) enriches Web mashup in a sense that it extends beyond Web and includes real world physical hardware and off-shelf software. CAMAR Mashup (CM) is more refined and specific form of mashup that is place specific (*in situ*) and real world-oriented by contexts of sensors, services and tags in the real world.

The main differences can be found in the intended target user group. WM and UM require users to be skilled technicians or experienced developers. However CM targets for end-users requiring no specific technological background. Also WM and UM do not open the mashup result to be manipulated by others. WM only opens its content through a limited API and UM is more focused on private uses. On

2. We adopt the definition of context from Dey's work [13], which define context as "context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves."

3. We use the term "classical" to categorize traditional mashup through typical API and Web site parsing.

Table 1. Comparison of mashup concepts

	Classical Web Mashup	Ubicomp Mashup	CAMAR Mashup
Working Domain	Web	Real World	Real World
Mashup User	Web Developer	Developer, Designer, Hacker	End-user
Mashup Target	Web Services	Web Services, Hardware, Software	Sensors, Services, Spatial Tags
Mashup Data	Data, Function	Toy's Shell, Scripting, Electronics	Context
Openness	API	Private Use	Public Sharing
Mobility	X	X	O
Presentation	Web Page	Tangible Artifact	Augmented Reality

the other hand, CM releases or opens the mashup result to the public and allows it to be shared and evolve through many iterations of mashup. Another difference is that WM and UM are developed in a stationary and static environment whereas CM serves for dynamic and mobile environment. For instance, WM takes place in a developer's office and UM takes place in a workroom. Unlike others, CM takes place in mobile and dynamic environment according to wherever the user go.

Lastly, different presentation methods are used by three concepts. WM mainly uses Web for presentation and UM normally presents a physical artifact that includes all the operating functionalities. CM takes an approach that falls between WM and UM. Collected context from sensors, services and tags from the real environment do not result in a physical output, but rather the output is presented as augmented reality overlaying virtual data onto the real world scene captured by camera. Figure 1 shows the concept of CAMAR mashup, highlighting the mashup enabled local space with targets within and corresponding mashup results retrieved from and updated to the corresponding virtual world.

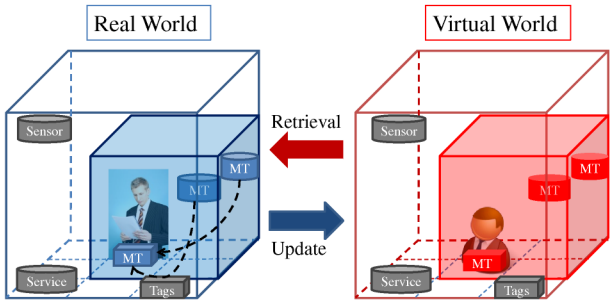

Figure 1. Concept of CAMAR mashup showing mashup enabled space with Mashup Targets (MT) within.

4. Scenario

In this section we describe a scenario for CAMAR mashup in an indoor museum as depicted in Figure 2.

4.1. Data and Function Mashup

In a mobile guidance system, a user is merely given information of a certain exhibit on site. The closed system limits users to just consume what has been provided to them, there is no way for users to change services they receive. The museum usually keeps a record of how many people are visiting certain exhibits with people counter. This information is generally not open to end-users and the data is not accessible. With CAMAR mashup, the user is able to add and combine contextual sensor readings to graph functions to visualize the data *in situ*. The user first discovers mashup targets in the front of an exhibit such as people counter sensor and a mobile phone's native graph function. The discovered resources and functions are displayed as widgets on the sidebar. Then the user can drag and drop a people counter widget on to the workspace first followed by a graphing function widget to create a graph visualization service of sensor readings. The author of this new mashup service can publicly open and post them by the signboard in the entrance of the museum so that other users can benefit from these services as well. Other users can simply take this service and modify it for his own needs or improve them by adding other functionalities.

4.2. In Situ Annotation

In user's everyday life, they take a note or make comments on things they encounter. For example in a museum, a user may leave a comment like "This exhibit is very interesting,

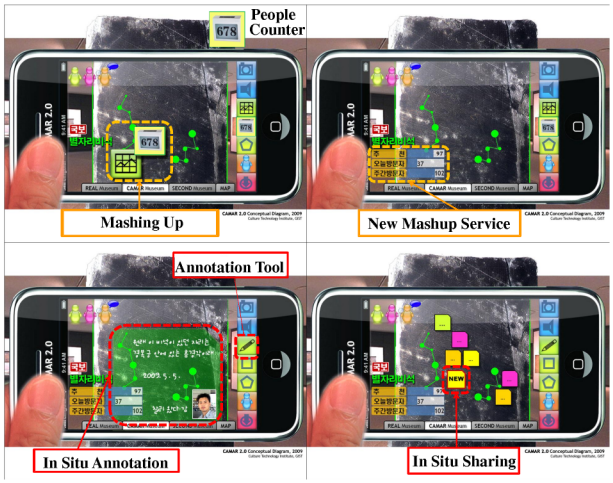

Figure 2. Service mashup and annotation scenario

which resembles a sculpture in my town - by Charlie". So the user can select an exhibit in the museum and make a text or voice note. More to the annotation, the user can link it with the pictures. To start adding an annotation, the user can select an annotation widget from the sidebar and select an area to leave an annotation. Also when the user leaves comments on a specific target, the surrounding context is internally mashed-up with the comments. The context of such an annotation is later used to filter and display the relevant information to other users. If the annotation is attached to a tombstone, it is reasonable to show this note to users whose camera view contains this tombstone. Ultimately these user contributions to the museum can show digital trails of users to encourage other users to see what others are thinking and doing and help create a sense of community and culture of participation.

5. Technical Challenges

In the presented CAMAR Mashup scenario there are many technical challenges and research issues to be resolved, especially in a mobile platform environment. First, an accurate localization method is required for accessing *in situ* mashup targets in a reduced search space. Since location context dominates what a user can mashup, at least an accurate room-level location is required. Second, a robust tracking solution for unknown environment on a mobile platform is required. Even though mashup processes can be done in a still image-based workspace, the visualization should be provided in a near-real time performance. Considerations of using user-defined tags, natural features and using virtual models from the virtual world are among many possibilities to enable an object-level tracking. Third, a standardized data model of mashup result is essential. CAMAR mashup needs a standardized data model, so it can be flexibly saved and retrieved for later uses. The data model of CAMAR mashup needs to incorporate *in situ* context of mashup targets and finer controls for user permissions on the sharing.

6. Conclusions and Future Work

In this paper, we proposed a concept of CAMAR mashup. CAMAR mashup is different to other mashup concepts in the aspects of where the mashup activity takes place, what kinds of targets it is compatible with, how it can be processed and presented, and how it empowers user participation. CAMAR mashup is an activity to combine context in the real world and augment the mashup targets with additional data and functions. Through a CAMAR mashup scenario in a museum setting, two possible applications and its technical challenges are discussed.

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