A Study on Web Augmented Reality based Smart Exhibition System Design for User Participating

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Abstract

This paper aims to provide design on augmented reality (AR) based smart exhibition system to encourage user participation. If the conventional way to observe exhibition was merely on visual of the products at hand, the smart exhibition that uses augmented reality will enable users to get in-depth information not only via text, image, and video, but also through 3D virtual object in real-time basis. The proposed smart exhibition system is marker-based system in utilizing augmented reality and to resolve the problem of the limitation of one marker per one virtual object, we applied the marker array list system. In addition, with the construction of web server, it enables user to use the system ubiquitously and by outputting marker in addition to exhibition, it allows for the indirect experiences. The system, after user authentication, classifies users, and divides module into content experience (spectator) module, content authoring (participant) module and system management (administrator) module.

Keywords: *Web, Augmented Reality, Smart Exhibition System, User Participating*

1. Introduction

With the expansion of ubiquitous computing and user-centric based system, the computing paradigm has altered dramatically affecting the everyday lives of ordinary citizens in a very short time. Case in point is the rising popularity of Smartphone where its key strengths are mobility and portability. Apple's iPhone was introduced in Korea in just 2009 but as of Oct. 2010, there are over 5 million Smartphone users[1]. The rapid proliferation of Smartphone can be attributed to the fact that users can conveniently download and use countless numbers of applications through open markets and developers in turn, can develop applications using an open API and distribute the apps easily. The majority of applications are, however, limited in the areas of game, education, and everyday productivity.

Recently, with the wide applications of Smartphone, AR that integrates the real word with the virtual is garnering wide attention. Although many researches have been conducted in high performance PC environment, only recently many researchers began studying on Smartphone as it increasingly became powerful with functions that include a camera, various sensors, 3G, Bluetooth, Wi-Fi, and others, making it an ideal environment.

An exhibition is generally structured where spectators view the displayed products and get the detailed information on the said products through either pamphlets or kiosk that is set nearby. Consequently, there are disadvantageous in that it lacks convenience and portability. This problem can be resolved by using Smartphone augmented reality technology. Augmented reality, based on how it is processed, is divided into marker and non-marker

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based. Looking at the strengths and weaknesses of each method, a marker based has strength in that it has superior recognition rate but as marker is visible, it reduces immersion. On the other hand, in case of NFT(Natural Feature Tracking) that is used most often in non-marker based, although it is praised for high immersion, it is slow and has poor recognition rate. In this paper, as surrounding of exhibition may have elements, such as lights, that may adversely affect recognition, the marker based has been chosen for accurate recognition. In addition, despite the fact that exhibition place has various exhibition products, there is limitation that one marker can only augment one virtual object[2]. Consequently, in this paper, a marker array list method has been applied and to maximize system's efficiency, a context aware method has also been applied.

2. Related Work

2.1. Exhibit Using Augmented Reality

Augmented reality is a technology that involves showing virtual information such as text or image onto image of real world in a real-time basis[3]. The first known research began in 1968 in the U.S. with the presentation of "Head Mounted 3D Display" by computer scientist Ivan Sutherland[4]. The words "augmented reality" was first coined by Tom Caudell while he was explaining the assembling process of wire of aircraft using the virtual image on top of the real life image[5]. Although mixed reality is sometimes used in the place of augmented reality, as shown in Figure 1 below, the mixed reality encompasses continuous spectrum from the real environment to the virtual environment[6].

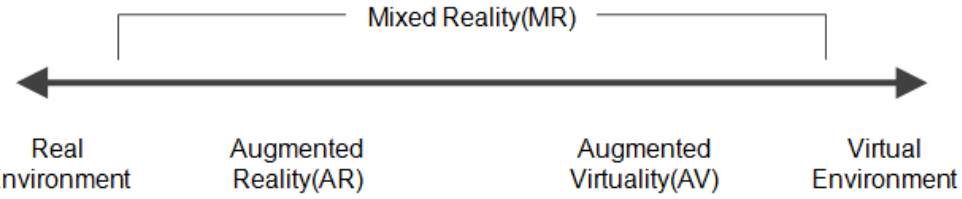

Figure 1. Simplified representation of a "virtuality continuum"

In researching AR related exhibition, we found Archeoguide system, Miniature AR system, and image restoration of museum that exemplify our study. The Archeoguide system[7], as shown below in Figure 2, aims to restore the cultural assets and artifacts that have been ruined with the passing of time by integrating a virtual 3D object with the real world. The said system is composed of a server, mobile equipment, wireless network, and tracking system, and users can request and check the original condition of cultural assets and artifacts.

Figure 2. Actual ruins(left) and restored ruins(right) of Archeoguide system

The Miniature AR system[8], as shown in Figure 3, integrates real miniature with digital content into AR and it is a digilog content experience system. Using the 3D interaction method that utilizes real-time camera trace and depth camera, it makes it possible for augmented virtual content and interaction for miniature without the need of tools.

Figure 3. Miniature AR System

The image restoration of museum utilizes AR[9] to restore the damaged parts of the past's artifacts in a museum and it can be used for educational purpose as well.

In reviewing the past case studies of augmented reality exhibition, we found that there lacks cases where Smartphone was utilized or context aware method was applied to provide user-centric tailored service. However, in case of miniature AR, using 3D interaction method there were results where it simulated the interest and immersion of users, confirming the need for interaction.

2.2. Context-Aware for AR

In ubiquitous computing environment, it is essential to provide service that are tailored to the interest of users rather than offering uniformed service. The context aware technology integrates real world with virtual space to provide intelligent service that makes the most of context information[10]. That is, by analyzing various elements, such as what a user is doing currently, where a place is located in, and what kind of people are nearby, it recognizes the current situation. The context information signifies all information that can be used from a point where a user conducts interaction and for proposed smart exhibition system, it includes data collected from a sensor, time, location, and user and exhibition profile. With collection and exchange of above information, it recognizes the situation and after the interpretation and inference process, it provides appropriate service to users.

2.3. Interaction for User Participating

A user requires natural interaction with various computing resources surrounding him. In particular, with respect to the interaction between the user and contents, AR allows a user to directly interact with virtual contents and services in the real world, which differentiates AR from virtual reality[11]. For example, Figure 4 shows how a user can move or rotate augmented virtual contents as well as adjust its size.

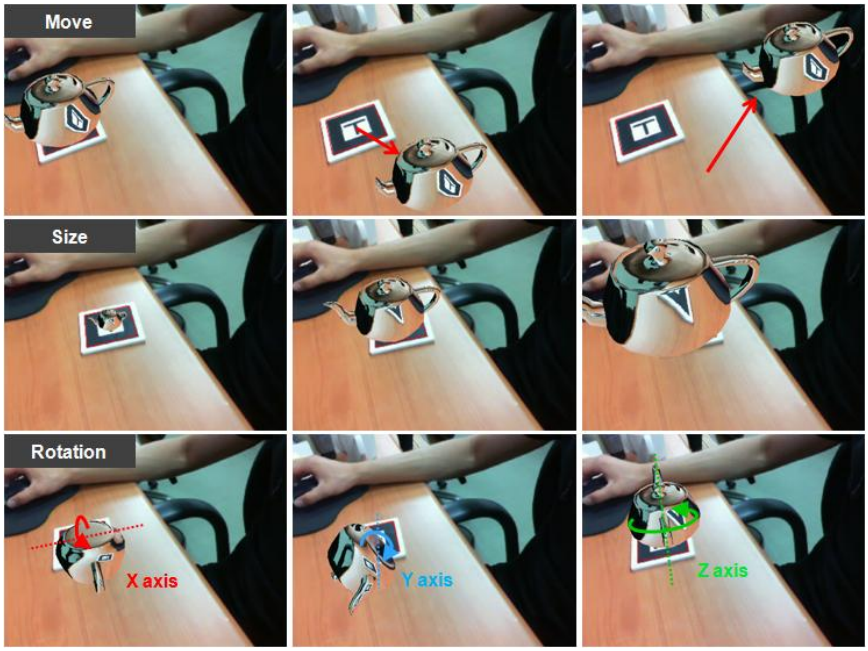

Figure 4. Interaction(move, size, rotation) of AR

3. Marker Array List

As depicted in Figure 5, a marker array includes a single marker containing various template patterns and a 4-area marker array by which each marker can be applied. Four markers located in each area can augment a total of 4^4=256 objects depending on application methods. The number is based on the precondition that single markers of the same pattern can be put into each area repeatedly. In case there is a multitude of markers repeatedly applied to an area, objects can be augmented without a recognition error by calculating the quantity of a marker per area.

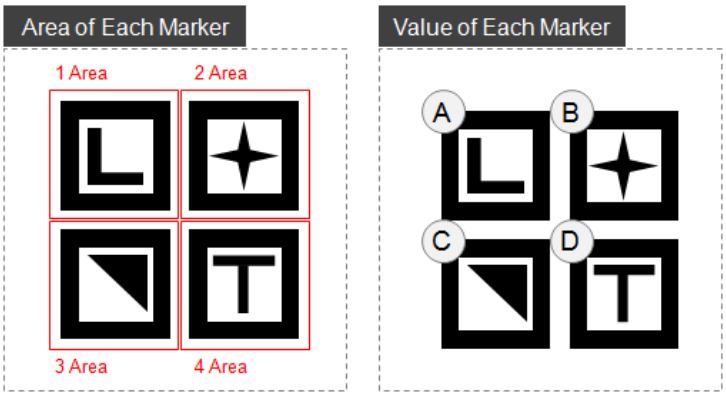

Figure 5. Area and Value of each Marker

ID is given to marker arrays which have different positions depending on the input sequence depicted in Figure 6. A list is created as ID is given up to 256 times. And users are identified, whose data are saved in DB to be managed. The list can be created by the system suggested in this paper for the exhibition participants, using a contents creation module. Even

if Participant A and Participant B create the four same markers and marker array list, the list is packaged per user and, thus, it is possible to augment different contents. In addition, a spectator can identify participants by locating their booths through GPS in a Smartphone.

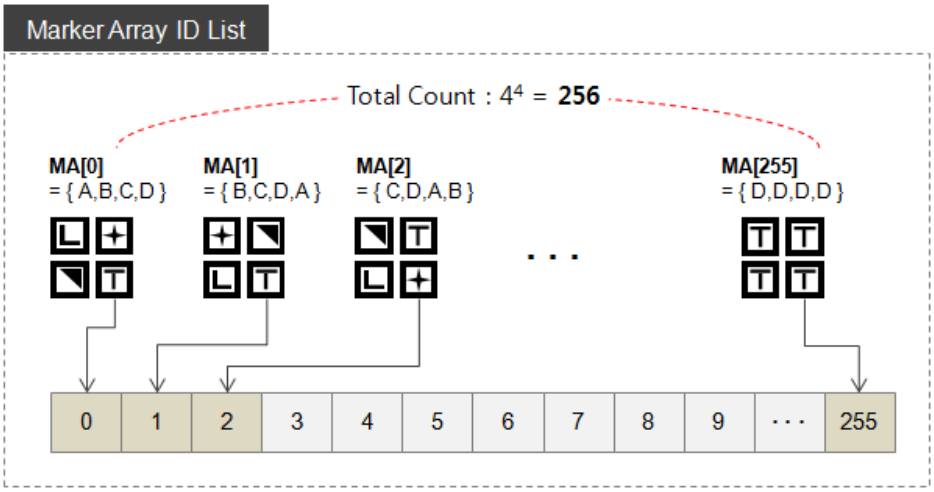

Figure 6. Marker Array List

4. Suggested AR Smart Exhibit System

4.1. System Configuration

The proposed AR smart exhibition system is composed of as shown in Figure 7 and as it is based on ubiquitous computing environment, users can download and use services ubiquitously using a Smartphone.

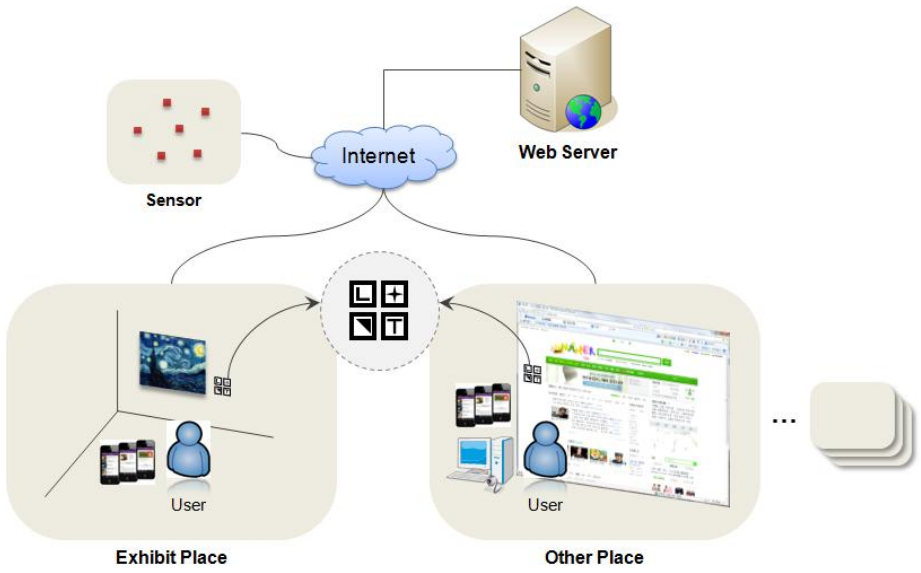

Figure 7. AR Smart Exhibit System Configuration

As demonstrated in the Figure 7, a user in an exhibit place first use a Smartphone to access a web server where an exhibition system is in place. Upon gaining access, when the user place a Smartphone on a marker located next to the displayed product, the user will received detailed information on the said product. Augmented exhibition information will infer from the situation at hand and select the most appropriate contents.

4.2. Classified by User Authentication

The activation of system begins with the user authentication. Through the user information contained in the web server, an administrator, a participant, and a spectator are classified beforehand and information on user profile is obtained. After membership is completed, to use the system, the user authentication, as shown in the Figure 8, goes through and system management, content authoring and content experience are classified into module and processed.

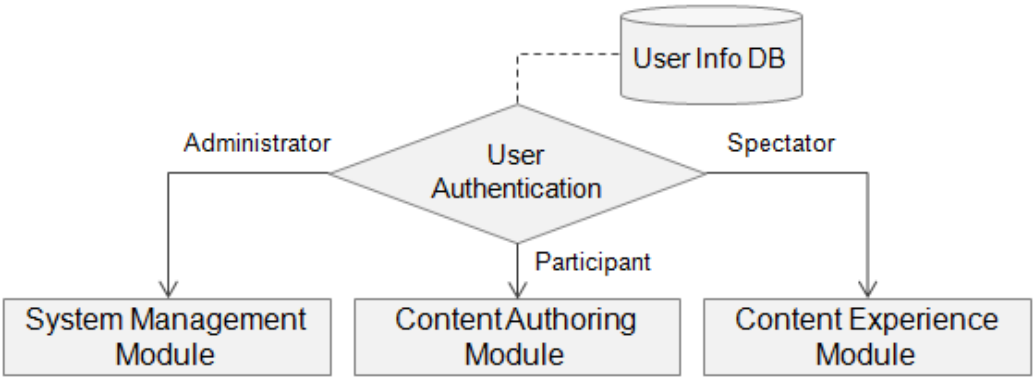

Figure 8. User Authentication and Classification

4.2.1. Administrator: The system management module that oversees the system, with the focus of processing AR and context awareness, carries out the separate role of managing the marker array list, gathering of sensor data, users, and exhibition.

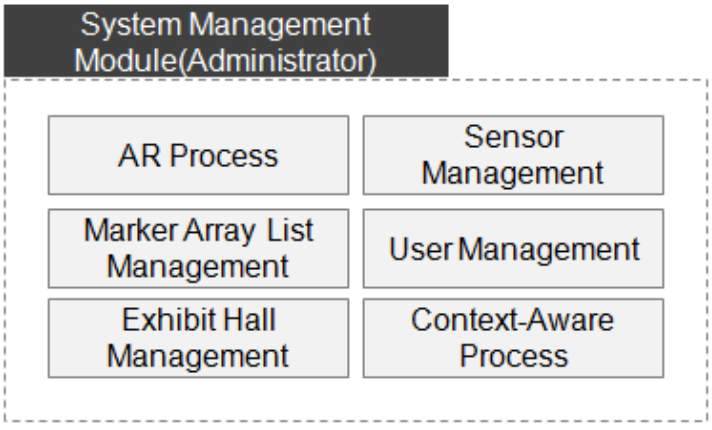

Figure 9. System Management Module

4.2.2. Participant: The content authoring module (participant) that prepares for exhibition, as shown in the steps of Figure 10 below, authors contents and prepares for exhibition information to be provided to spectators.

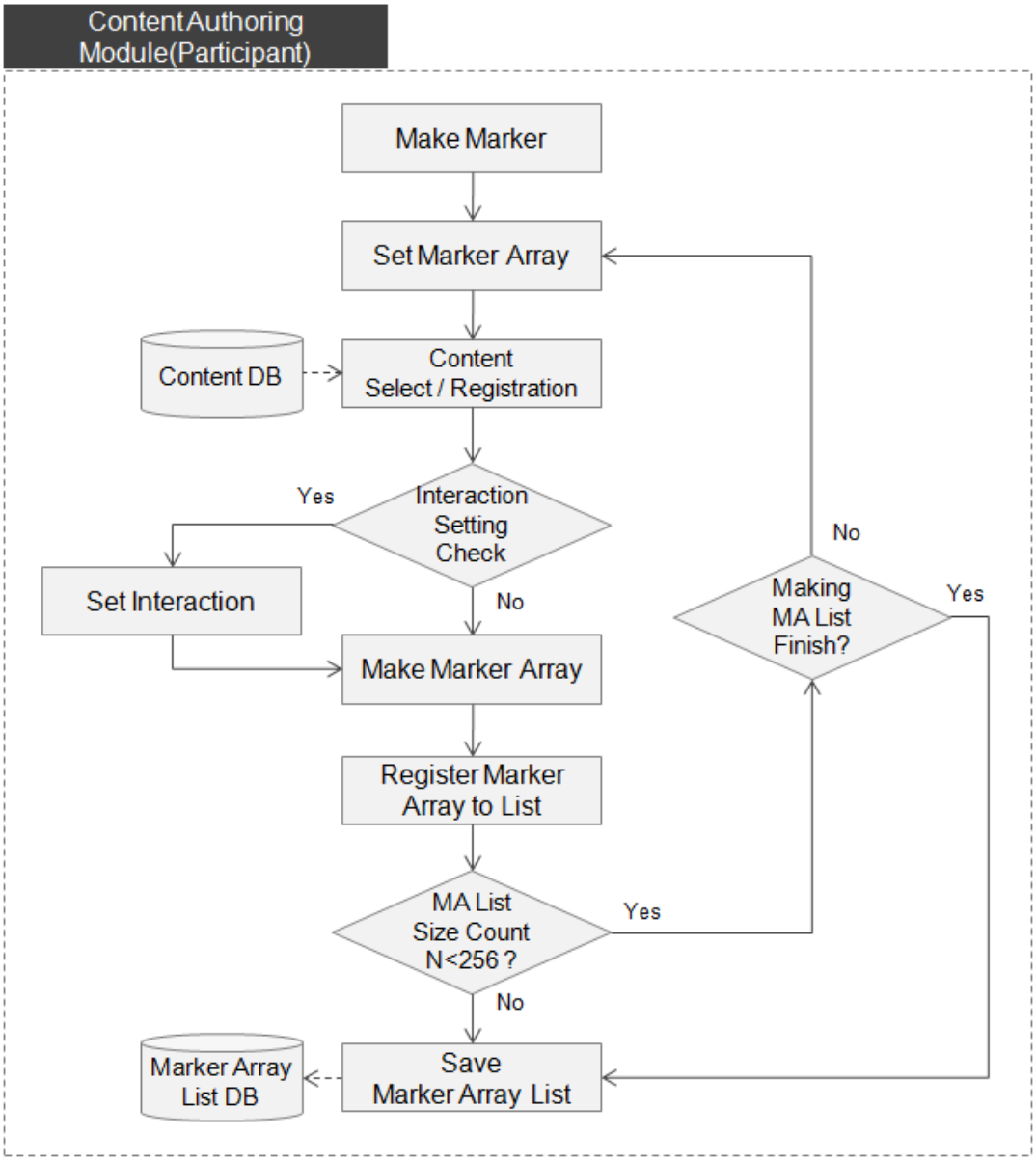

Figure 10. Content Authoring Module

The order of content authoring module is as follows and registered marker array list is recognized in the content experience module (spectator) and augments registered contents.

1. Constructs marker patterns and generates markers

2. Prepares four markers, determines the pattern value of each marker and range and generates marker array

3. Selects/registers augmented contents following the generated marker array

4. After checking the specific interaction of contents, selects interaction

5. Generates marker array

6. Registers marker array list

7. Checks whether marker array list value is larger than 256

7-1. If true, after checking whether the making of marker array list will be completed, either generates additional marker array or saves into DB

7-2. If false, saves the latest registered marker array list into DB

4.2.3. Spectator: For content experience module (spectator) that observes exhibition products that were prepared beforehand, it distinguishes participants through the location information from exhibition booth and augments contents by recognizing each participant's marker array list. Augmented contents control specific interaction and enable more detailed information on exhibition.

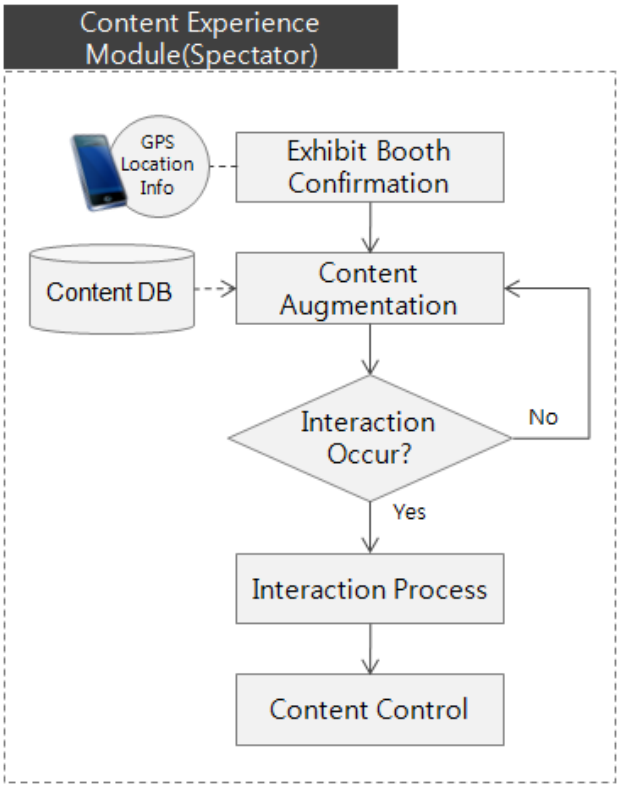

Figure 11. Content Experience Module

4.3. Context-Aware and AR Process Structure

The context aware processing, as shown in Figure 12, through the web's member join service, using the collected data from various sensors, including user profile, exhibition hall profile, marker array list and others in "context middleware", processes advanced context information.

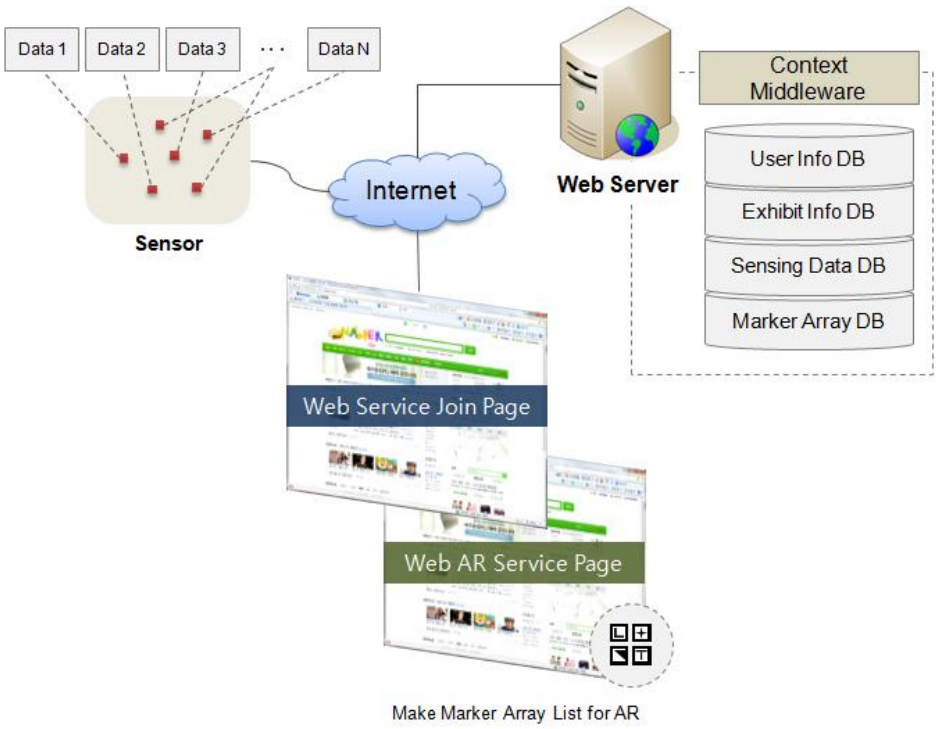

Figure 12. Data Collection and Access for Context-Aware

The processed context information in turn, in "context aware module", infers situation following the specified case or rule. The inferred context, through feedback in "AR Process" phase, augments content or is used to process interaction.

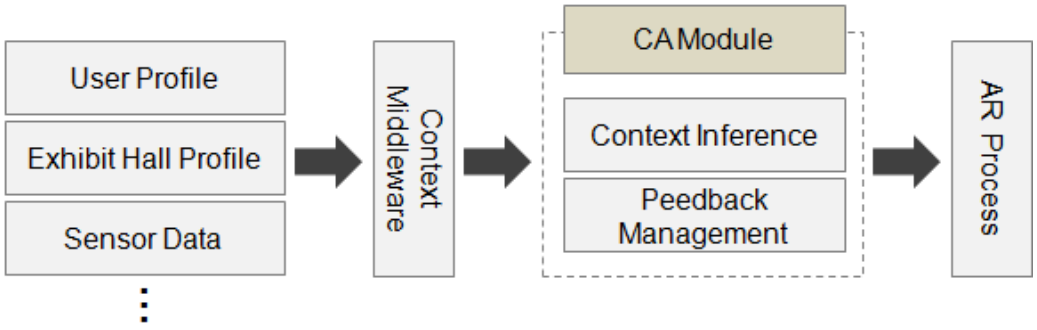

Figure 13. Context-Aware Process in Suggested System

AR process, as shown in Figure 14, when the marker based AR is processed, the marker array list and context aware module that infers the context in "context aware process" phase are added. The context aware module, when marker array does not exist, following the feedback through inference, augments the related contents.

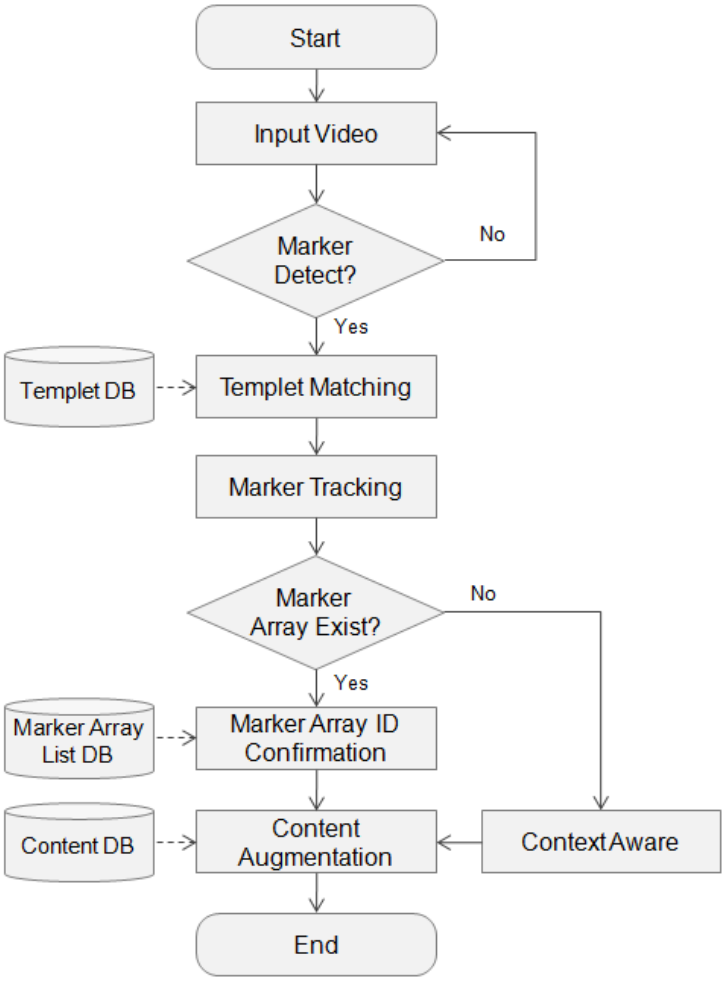

Figure 14. AR Process in Suggested System

5. Conclusion

This paper, in light of the fact that the plan to use Smartphone is nonexistent in exhibition and the following demand by users for detailed information on the exhibition products, we designed AR smart exhibition system grounded on web environment. In addition, to resolve the limitation of one marker per object in existing AR, we proposed for marker array list method. The proposed system is not confined to exhibition but to other areas as well where users demand relevant information. However, the marker may interfere with the observation of exhibition products and passive interaction may not stimulate the interests of users. Consequently, in the future, we seek to research on non-marker based AR and construct improved system, as well as on dynamic interaction that is appropriate to the situation.

Acknowledgement

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References

[1] Naver Cast, “Smart Phone”, http://navercast.naver.com/contents.nhn?contents_id=4128

[2] S. Jung, J. Song, D. Hwang, J. Y. Ahn, S. Kim, “A Study on Software-based Sensing Technology for Multiple Object Control in AR Video”, Sensors, vol. 10, no. 11, 2010, pp. 9857-9871.

[3] R. Azuma, “A Survey of Augmented Reality”, Presence: Teleoperators and Virtual Environments, vol. 6, no. 4, 1997, pp. 355-385.

[4] I. Sutherland, “A Head-Mounted Three-Dimensional Display”, Fall Joint Computer Conf., Am. Federation of Information Processing Soc. (AFIPS) Conf. Proc. 33, Thompson Books, Washington, D.C., 1968, pp. 757-764.

[5] T. P. Caudell, and D. W. Mizell, “Augmented Reality: An Application of Heads-Up Display Technology to Manual Manufacturing Processes”, Proceedings of 1992 IEEE Hawaii International Conference on Systems Sciences, pp. 659-669.

[6] P.Milgram and F. Kisruno, “A Taxonomy of Mixed Reality Visual Displays”, IEICE Trans. Information Systems, vol.E77-D, no.12, 1994, pp.1321-1329.

[7] V. Vlahakis et al, “Archeoguide: An Augmented Reality Guide for Archaeological Sites”, IEEE Computer Graphics and Applications, vol. 22, no. 5, September/October 2002, pp. 52-60.

[8] K. Kim, Y. Park, W. Baek, W. Woo, “Miniature AR: Augmented Reality based Display System for Experiencing Next Digilog-type Contents”, Spring Next-generation PC Conference, 2009, pp. 35-41.

[9] K. S. Won, “Application Method of Image Restoration based on Augmented Reality to Museum Education”, Journal of the Korea Contents Association, vol.10, no.6, 2010, pp. 205-212.

[10] Matthias, B., Schahram, D., Florian, R., “A survey on context-aware systems”, International Journal of Ad Hoc and Ubiquitous Computing, vol.2, no.4, 2007, pp. 263-277.

[11] Julier, and B. MacIntyre, “Recent Advances in Augmented Reality”, IEEE Computer Graphics and Applications, vol.21, no.6, 2001, pp.34-47.

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