# Development of Mobile AR Tour Application for the National Palace Museum of Korea

Jae-Beom Kim and Changhoon Park

Dept. of Game Engineering, Hoseo University,
165 Sechul-ri, Baebang-myun, Asan,
Chungnam 336-795, Korea
re.ho.mik@gmail.com, chphark@hoseo.edu

**Abstract.** We present the mobile augmented reality tour application (MART) to provide intuitive interface for the tourist. And, a context-awareness is used for smart guide. In this paper, we discuss practical ways of recognizing the context correctly with overcoming the limitation of the sensors. First, semi-automatic context recognition is proposed to explore context ontology based on user experience. Second, multiple sensors context-awareness enables to construct context ontology by using multiple sensor. And, we introduce the iphone tour application for the national palace museum of korea.

**Keywords:** Mobile, Augmented Reality, Tour, Semi-automatic context recognition, Multi-sensor context-awareness.

## 1 Introduction

We introduce an ongoing project to develop an mobile AR tour application for the national palace museum of korea running on the iphone. Every exhibit in the museum has its own name and history. For richer experience, this application is based on the augmented reality to make that content available to tourists interacting with exhibits by enhancing one's current perception of reality. Moreover, we also support AR content authoring in situ to share their experiences of exhibits.

When the visitor see a exhibit through iPhone's camera, relevant information to the captured real images will be provided. To achieve this, the tour application is developed based on a client-server architecture. The client sends the query image to a remote server for recognition process, which extract visual features from the image and perform the image mach against large database of reference images by using SIFT(Scale-Invariant Feature Transform) algorithm. Once the matching image is found, the client render and overlay computer-generated virtual elements about the objects in it. And, the client continuously tracks the viewing pose, relative to the real object for image registration. Compass and gyroscope sensors of iPhone 4 are used for tracking.

R. Shumaker (Ed.): Virtual and Mixed Reality, Part I, HCII 2011, LNCS 6773, pp. 55–60, 2011.


**Fig. 1.** Overview of the Mobile Augmented Reality Tour (MART) Application

## 2 Context-Awareness for MART

We have been researching mobile augmented reality tour(MART) applications to provide intuitive interface to the visitor. And, the context-awareness is used to support a smart tour guide. In this paper, we discuss practical ways of recognizing the context correctly with overcoming the limitation of the sensors. And, this approach is implemented in the iphone tour application for the national palace museum of korea.

**Table 1.** Three key steps for context-awareness

| Step | | Input | Output |
|---|---|---|---|
| 1. | Context Recommendation | Name of the sensor data (automatic) | Candidate Contexts |
| 2. | Context Exploration | User input (manual) | Best Matching Context |
| 3. | Resources Offer | User input (manual) | Multimedia, 3D Model, Other applications ... |

First step is to recommend candidate contexts by using the name of the captured data from the sensor. This name can represent identification and characteristics of the sensor data. For example, this name can be retrieved from GPS coordinates with the help of google places API that returns information about a “place”. In second step, the user can find the best matching context for the situation. Because of the limitations of sensor, it is difficult to recognize all contexts by using only the sensor. So, it is allowed for the user to explore the ontology based context manually. Third step provides the list of resources available for the specific context.

### 2.1 Semi-automatic Recognition of the Context

This paper propose an efficient way of exploring context ontology based on user experience. We use the past experience to minimize the cost of context exploration of second step mentioned previous section. Interesting contexts receive a higher reference count that stands for the user's visiting frequency. And, these contexts are more likely to appear at the top for exploration.

For example, the "public place" context can not be provided directly from GPS sensor. Instead, the user can find "public place" context in the ontology from the high part of the "Museum". And, if there is no service for indoor location, "ticket booth" context cannot be provided directory by using only the sensor. But, the user can find "ticket booth" context from the low part of "Museum" context. After all, context ontology includes the context reduced by sensor or not. This semi-automatic approach will enable provide appropriate contexts to the user quickly with overcoming the limitations of sensor.

To apply the experience, context ontology records how many times the context is referenced by the user. And the order of displaying context is depends on this value. In addition to this, the experience of friends are also be considered with different weight ratio for the calculation of interesting. This approach based on experience will be expected to reduce not only the cost of context exploration but also support the sharing of experience.

### 2.2 Multiple Sensors Context-Awareness

We propose a way of constructing context ontology to define more concrete contexts by using multiple sensor. To achieve this, context is limited related to at mote one kind of sensor. If there are two sensors for context recognition, we can find two contexts in the ontology where there is a path between them.

For example, the visitor can take a picture with current location by using camera and GPS sensor. Then, we can find the name of captured image and the name of location. Several contexts can be founded by using these names. And, we will provide a context if there is a path between two contexts. This means that there is a sensor hierarchy. Low level context is affected by high level context. High-level sensor affect on it;s lower-level contexts. After all, we can define concrete contexts by combining multiple sensors on the context ontology.

We can find the name of object by using camera. If there are two more than contexts reduced by this name, this means that there are the same things in the world. Then, we can restrict the scope by using GPS by adding the context reduced by camera into the low level of the context by GPS.

## 3 Mobile AR Tour Application

In this section, we introduce the key implementation method of the iphone tour application for the national palace museum of korea. The AR Media Player makes content available to tourists interacting with exhibits by enhancing one's current perception of reality. And, In-situ authoring and commenting support AR content authoring in situ to share their experiences of exhibits.

### 3.1 AR Media Player

The client consists of 3 layers: live camera view, 3d graphic rendering and touch input. First, we make a layer to display video preview coming from the camera. Second layer is for the rendered image of virtual world. In virtual world, interactive virtual character will explain about what the camera is seeing. We ported OpenSceneGraph to the iPhone for real-time 3D rendering. OpenSceneGraph is based on the concept of scene graph, providing high performance rendering, multiple file type loaders and so on. And, This layer clears the color buffer setting the alpha to 0 to draw 3D scene on the top of the camera view layer. So, the camera view layer will be shown in the background. The third layer is provided for GUI.

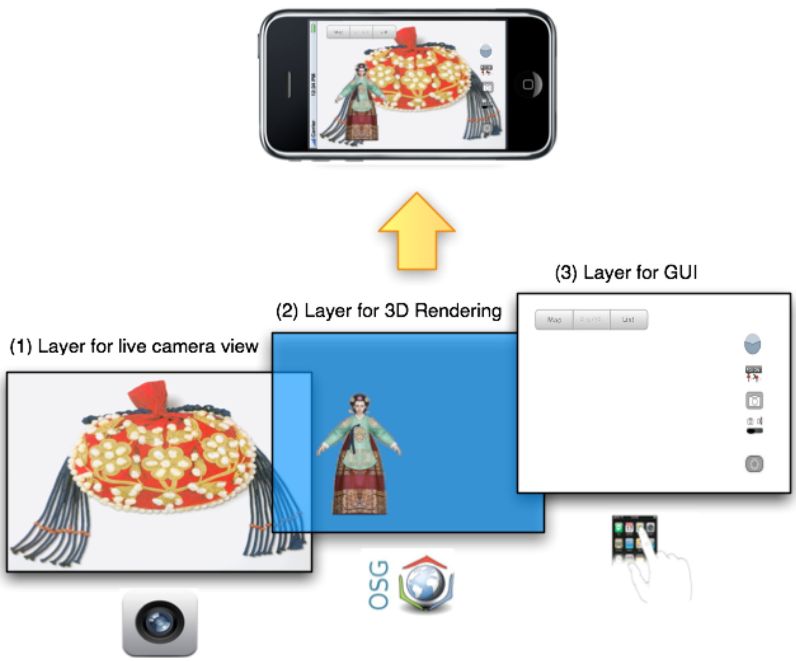


**Fig. 3.** AR media player consisting of three layers: live camera view, 3D rendering and GUI

### 3.2 Image Query

The tour application send a query image automatically without user input. If the live captured image on the screen is identified by the server, the green wireframe rectangle will be displayed like the below figure. This approach is very intuitive and natural, but the cost of network should be considered. To reduce bandwidth usage, we change the size and resolution of image for query. And, the client use acceleration and compass sensor to decide when is the best time to send query image. The movement of iphone enables to detect when the user focuses attention on the particular exhibit or not. So, we can control the frequency of sending the query image.

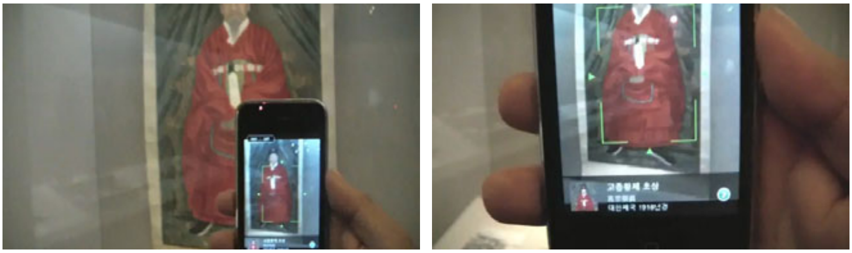

**Fig. 4.** Image query running on the iPhone 4 without user input

### 3.3 In-situ AR Authoring

The client provide an interface for in-situ authoring of AR contents on the iphone as the below figure. This interface enables to create visitor's own contents for a specific exhibit on the spot. And this content can be shared with others who are also interested in the same exhibit. We will suggest an efficient and easy way of in-situ authoring with overcoming the limitation of mobile devices.

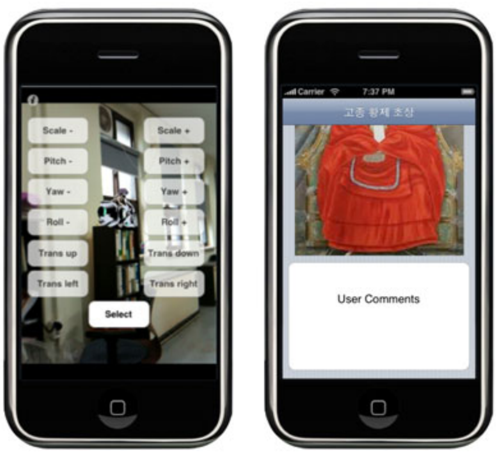


**Fig. 5.** In-situ AR authoring and commenting on iPhone

## 4 Conclusion

In this paper, we presented practical way of recognizing the context correctly with overcoming the limitation of the sensors. Semi-automatic recognition of the context is proposed to reduce not only the cost of context exploration but also support the sharing of experience. And, we introduced multiple sensor based context-awareness to define more concrete contexts by using multiple sensor. Promising results were demonstrated in the iphone tour application for the national palace museum of Korea.

**Acknowledgement.** "This research was supported by the Academic Research fund of Hoseo University in 2009" (20090082)

## References

1. Park, D.J., Hwang, S.H., Kim, A.R., Chang, B.M.: A Context-Aware Smart Tourist Guide Application for an Old Palace. In: Proceedings of ICCIT (2007)
2. Adomavicius, G., Tuzhilin, A.: Context-Aware Recommender Systems. Technical Report, `http://ids.csom.umn.edu`
3. Seo, B.K., Kim, K., Park, J., Park, J.I.: A tracking framework for augmented reality tours on cultural heritage sites. In: Proceedings of VRCAI (2010)
4. Riboni, D., Bettini, C.: Context-Aware Activity Recognition through a Combination of Ontological and Statistical Reasoning. In: Zhang, D., Portmann, M., Tan, A.-H., Indulska, J. (eds.) UIC 2009. LNCS, vol. 5585, pp. 39–53. Springer, Heidelberg (2009)
5. Gellersen, H., Schmidt, A., Beigl, M.: Multi-Sensor Context-Awareness in Mobile Devices and Smart Artefacts. Mobile Networks and Applications 7(5), 341–351 (2002)
6. Lim, B.: Improving trust in context-aware applications with intelligibility. In: Proceedings of Ubicomp, pp. 477–480 (2010)