3D Graphics Visualization and Context Information Service for a Virtual Tourist System

Congdu Nguyen*, Minh Tuan Le, Dae-Il Yoon, and Hae-Kwang Kim

***Abstract* — In this paper, we present a virtual tourist system with real-time 3D visualization and the assistance of context information service. Our system enables a visitor to take a discovering tour on a virtual environment from a remote client by following navigator or by self-navigating. During the tour, the system provides immersive 3D graphics contents while supporting relevant information to the visitors corresponding to their positions in the virtual environment. When the visitors interact with interested objects, the context information service will also support introduction information for presenting about the objects. The introduction information based on text format is represented by a comfortable way - audio conversion to visitors in different languages depended on their preferences using TTS (Text-To-Speak) tool.**

***Index Terms* — Virtual Tourist System, 3D Graphics Visualization, Context Information Service**

I. INTRODUCTION

Tourists are usually happy to carry around with a guidebook describing about the location they are visiting and cultural and history of their current location, etc. Nowadays with the increment of hi-tech tourism information and services can be packaging in the form of a hand-held device. The provided information can be contextually represented to the tourists by a combination of text, video, images, and audio according to tourist interests, contexts. The system doing this work is called ubiquitous tourist guide.

A number of papers have been proposed tourist guide systems for assisting the tourists in traveling without person guider [1]-[7]. Similar to paper guides (guidebooks), a large share of mobile guides also provides visual location information relying on maps that can be 2D-maps [1] or 3D-maps [2]-[4]. These systems support tourists on the navigation by means location-aware services with personalized information and history of the exhibits about their interests and interactions, or give suggestions/recommendations regarding to the tourists' requests or help the tourists in organizing and scheduling an individual tour.

The mobile tour guide systems in supporting a learning environment are introduced. At the same time of visit exhibits, tour guide systems serves rich knowledge such as text, voice, and video clips for describing the exhibit objects according to the current position, their interests and visit history [5]-[7]. The visitors can receive the relevant information about what they see and whenever they are, the requests for a route related to point of interest are accepted by the system while they walking in the real world. The following systems are examples: INTRIGUE [8], COMPASS [9], Imogl [10], DTG (Dynamic Tour Guide) [11]-[13], CRUMPET [14], GUIDE [15]-[17], Cyberguide [1], [18].

In contrast, the tours without having to participate in the real world in person are the virtual tours. The systems support this kind of tours is referred to as virtual tourist systems. The approaches are similar to that museum and virtual libraries are seeking ways to expand access of their collections to a wide audience who can not otherwise visit to the museum during the short interval of showings. These systems are useful for education, advertisement, tour in museums or cities. VirtualTour [19] was developed with a purpose of taking a business on marketing. The VirtualTour marketing system allows sellers to easily advertise their products through the VirtualTour by touring on pictures with introduction information. ReGeo system [20] offers real-time 3D model inside the Web application that is accessible by offline, online and mobile platforms. The system also supports 2D and 3D visualization, audio, video. S. Wu [21] and J. Li [22] introduced a method of creating virtual tour for a campus based on cylindric panorama technology. S. Wu's research of focused on how to capture images and solving problem of generating the panorama images from a collection of images. But, J. Li's research is interested in how audience can access and walk through the virtual tour at different viewpoints. Anther kind of virtual tour is through a single image called Tour into the pictures [23]-[25]. The basic of this method is map the picture into 3D environment and setup a virtual camera for the tour.

Most above methods do not offer interactive immersive 3D environment, and serve introduction information according to context of interaction and user interests. M. Pollefeys [26] presented a toured guide method using natural speech and 3D face model guider for a virtual tour (virtual Sagalassos). The 3D virtual environment of ancient site of Sagalassos is reconstructed using CAD system. However, the tour on this system is inflexible in supporting information and is difficult for us to customize the tours. Our system, interactive 3D graphics visualization system in supporting virtual tour, is developed to solve these above limitations. Even there are many researchers investigated in context-aware computing for wide areas, but a few literatures discovered and used the facilities of context-aware for virtual tourist services that support adaptive and immersive 3D graphics contents. Our research focuses on context information service for providing relevant tourism information and interaction autonomously and content adaptation service for accommodating 3D graphics contents.

The paper is organized as follows. A general framework of the virtual tourist system is presented in section 2. The modeling of virtual tour information is introduced in section 3. The context information service is presented in section 4. The im-

Manuscript received May 10, 2006; revised Aug. 15, 2006.
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plementation of system is presented in section 5. Conclusion is discussed in section 6.

II. System Framework

Figure 1 depicts the overview of virtual tour guide system with the assistance of guided tour process, context-aware services for supporting introduction information, and for offering immersive 3D graphics contents. The system is composed of four main parts. First, database management system manages the 3D virtual environments and relational information related to the navigation process, user. Second, adaptation server plays important roles of visualizing and rendering 3D graphics model, adaptively providing rendered images to the user according to the context. Third, 3DViewer supports an interface environment that allows user accessing to a virtual tour resided in the adaptation server through the network environment (wire, wireless). Fourth, Design tool is developed to support managers in creating and managing navigation information, and scenarios.

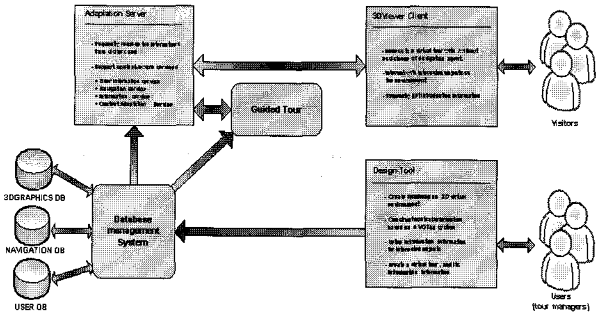


Fig. 1. A general framework of virtual tourist system.

Database management system organizes and processes information related to the discovering tour, users and 3D virtual environments. The information for the 3D virtual environment is its name, stored location, description that is stored in 3DGRAPHICS DB. User information including name, interests, and personal information that is stored in USER DB. Navigation information is composed of name, description, name of 3D virtual environment, the information of roadmap, VGTags, and interested objects. The navigation information is stored in NAVIGATION DB.

III. Virtual Tour Information Modeling

The information of a virtual tour is modeled by three layers: 3D layer, data layer, navigation layer as illustrated in figure 2. The 3D layer modeled for information of 3D virtual environments that can be presented as follows.

$$3DVir = \{M_1, M_2, ..., M_N\} \qquad (1)$$

Where M_i are 3D virtual environments (called 3D models) i from 1 to N, N is number of 3D virtual environments. The data layer contains information of VGTag system (VGTS), and interested object system (IOS). The VGTS is a collection of a number of VGTags that can be described by Eq. 2.

$$VGTS = \{VGTag_1, VGTag_2, ..., VGTag_n\} \qquad (2)$$

The IOS is a collection of interested objects (OIs) referred to as marked objects that is presented by Eq. 3.

$$IOS = \{IO_1, IO_1, ..., IO_k\} \qquad (3)$$

Where n is the number of VGTags and k is the number of *IOs* for an interested object system, respectively.

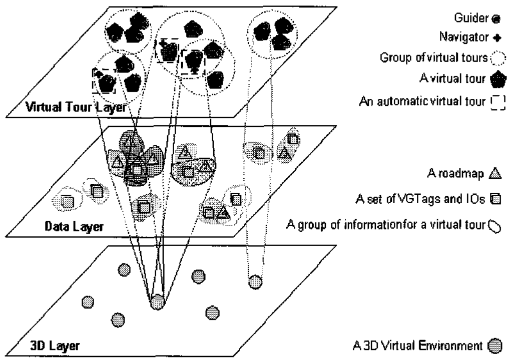


Fig. 2. The general framework of virtual tourist system.

The virtual tour layer contains navigation processes with and without the assistances of the navigators. These processes are described by Eq. 4.

$$LNV = \{NV_i\ [, NA_i, RM_i]\ |\ i = 1 ... p\} \qquad (4)$$

Where [, NA_i, RM_i] indicates that it is an option. *NA* is the navigator; *RM* is the roadmap; *NV* is the navigation process that is described by Eq. 5.

$$NV = \{VGTS, IOL, M_i\} \qquad (5)$$

Next we will describe more detail about information, and structure of VGTag, interested object (*IO*) and roadmap (*RM*).

3.1 VGTag

The user can walk through the 3D virtual environments by themselves or attend the tours by following a navigator. During tour time, to provide introduction information corresponding to the position of the user in the 3D virtual environment, we introduce a map of VGTags in the 3D virtual environment as shown in figure 3. These VGTags are marked to the attractive places/objects called targets that are needed to be introduced to the user.

Each tag has an identification number called *TagID*, and its data including the position *(x, y, z)* and orientation view *(h, p, r)* of the tag, introduction information *IF*, and supported thresholds (T_p, T_v). The VGTag can be parameterized by Eq. 6.

$$VGTag = \{TagID, P, V, IF, T_P, T_v\} \qquad (6)$$

Where, P and V are position and orientation view of the VGTag in 3D virtual environment, respectively. *IF* is introduction information it defined as a text, T_p and T_v is defined as the supported thresholds.

During tour time, Guider senses the current position P_c and orientation view V_c of the visitor and calculates the positioning distance D_1 from current position to the nearby VGTag and the oriented distance D_2 from the current orientation view to the orientation view of the nearby VGTag as shown in Eq. 7.

$$D_1 = \|P - P_c\| \quad and \quad D_2 = \|V - V_c\| \qquad (7)$$

Context information service will provide introduction information to the user based on the following rule.

$$\text{if}((D_1 < T_p) \,\&\&\, (D_2 < T_v)) \qquad (8)$$
$$\text{Show (IF)} => \text{the user;}$$

Where T_p and T_v are thresholds of nearby VGTag, P, V and *IF* are position, orientation view and introduction information of nearby VGTag.

3.2 Interested Object

During tour time, visitors can interact with the objects of interests for archiving further information and services. Therefore these objects should be indexed and their information and services have to define. Interested object is named as IO.

$$IO = \{OID, OIF\} \qquad (9)$$

Where OID is object identification, OIF is introduction information defined by text data for object OID.

3.3 Roadmap

Roadmap information is a tour-path used for a navigation process executed by the navigators. A roadmap is composed of a series of path-segments. Each path-segment can be a line segment, and a curve segment as shown in figure 4. Besides, we also define two special segment types: delay segment, and speed segment. A line segment is defined by two parameters: a start, and an end point. A curve segment is defined by radius. The curve segment (C) is depended on the end parameter of previous line segment (B of line AB) and the start parameter of next line segment (D of line DE). A speed segment is defined by two parameters: desired and rate. A delay segment is defined by delay parameter that indicates the time for this segment.

IV. CONTEXT INFORMATION SERVICE

4.1 Guided Tour

In increasingly mobile and heterogeneous environments, media contents must be adapted and provided intelligently to the recipients, also taking into account the capacity of the receiving device, and interactions. This is also an interesting dimension in creating content adaptation and context information service. For providing relevant information and traveling according to the roadmap, the system uses a Navigator for supporting automatic tour through 3D virtual environment and Guider for supporting introduction information to user during the tour.

4.1.1 Navigator

The navigation process can be performed by human or navigator. The navigator accesses roadmap information for calculating camera parameters (the positions, directions) of the participated user in the 3D virtual environment. These camera parameters are used for adjusting the camera in 3D graphics process as shown in figure 5.

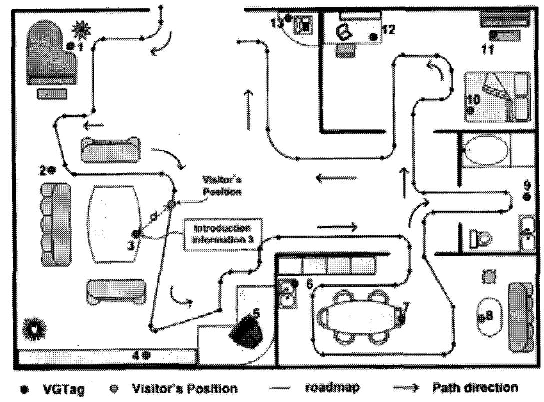


Fig. 3. VGTag system and roadmap in a virtual environment.

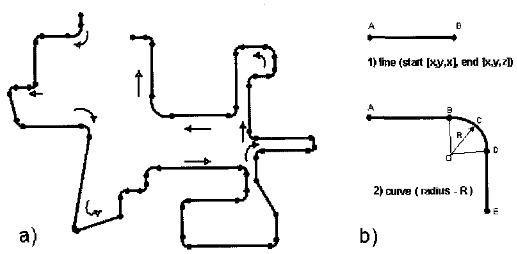


Fig. 4. a) a roadmap in a virtual environment, b) taxonomy of path-segments.

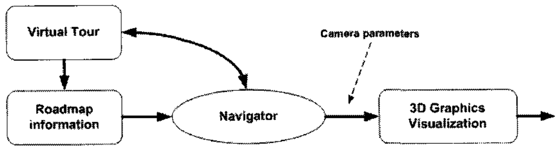


Fig. 5. Navigator for the virtual tour.

4.1.2 Guider

During the navigation, interactive information service system will provide introduction information according to the current position and direction view of the user in the 3D virtual environment, and depending on the user interaction on the interested object. Guider is established to decide when and what information will be provided to the user. The process is illustrated in figure 6.

Guider frequently receives the current status of the visitor for evaluating the positioning distances between current position and the position of VGTags and the viewing distances between current direction view and the direction view of VGTags. If the positioning and viewing distances are in supported range of the thresholds of VGTags, then the interactive information service system provides introduction information to the user. When the visitor interacts with an object, Guider finds out this object in DB and requests interactive information service system provide related information and services to the user.

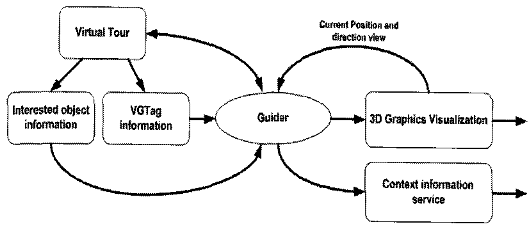


Fig. 6. Guider for context information service in supporting relevant information.

V. VIRTUAL TOURIST SYSTEM

Virtual tourist system is composed of an adaptation server, a design-tool and a 3Dviewer that were implemented using Visual C++ 6.0, OpenGL API and OpenGL Performer Library [32]. 3DViewer (PDA version) was implemented using Visual Studio 2005 (Windows CE 2005).

A 3DViewer, a real-time client viewer offering adaptively representing and navigating a 3D graphics model, is specially developed for mobile devices (HP iPAQ Pocket PCs) and PCs. In previous works [27]-[30], the clients need time-delay for downloading the 3D scene, a large memory space for storing data and required graphics hardware for accelerated 3D rendering. In our method, a video streaming technique is employed instead of streaming 3D model for solving the above limitations and for accelerated representing a large-scale 3D model. A 3D model resided in the adaptation server is rapidly represented by the client viewer without having to download and store it as well. In this study, we are taking advantages of the video streaming technique due to the low computing capacity of the clients and the potential low bandwidth of wireless links [31].

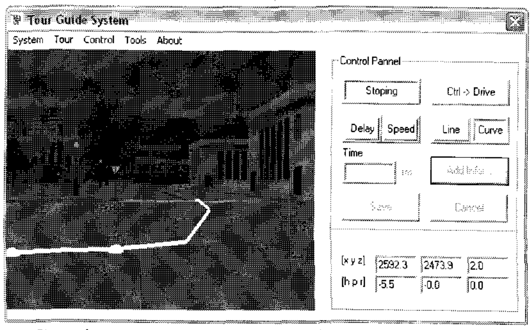


Fig. 7. Creating roadmap for a virtual tour.

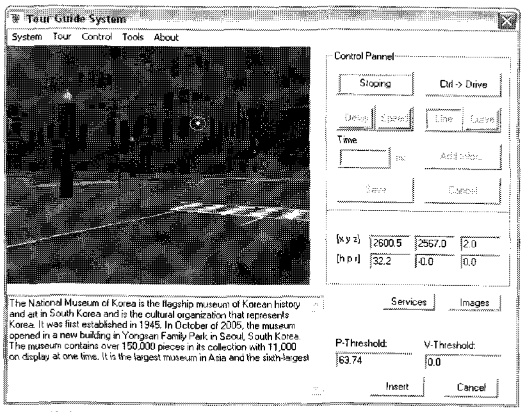


Fig. 8. Editing introduction information for a VGTag.

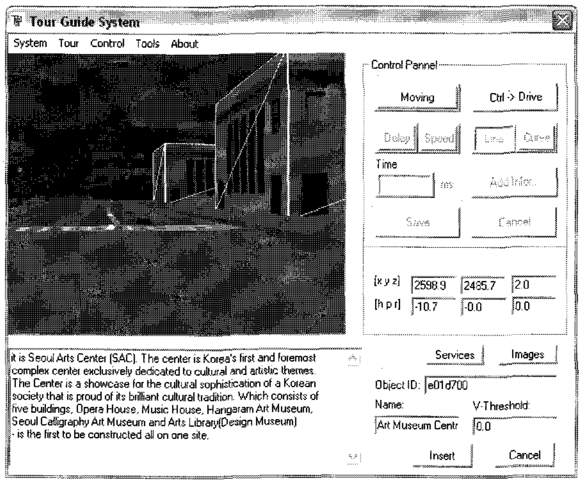


Fig. 9. Editing introduction information for interested object.

Client nodes can be HP iPAQ PocketPCs working on WinCE 2005 and PCs working on Window XP platform. PocketPC devices currently have a small screen resolution – 240 x 320 pixels and 16/32 bit color depth. In this experiment, video coding standard is used to encode the input images into video stream and UDP/RTP is used to pocketsize and stream generated video data to the client over the wireless links. The sizes of video compression: Quarter Common Intermediate Format (QCIF – 176 x 144) is used for PDA version, and Common Intermediate Format (CIF – 352 x 288) is supported for PC version.

5.1 Design a Virtual Tour

Design-tool is developed to allow the user creating the roadmaps of virtual tours, and editing introduction information for interested objects and for VGTag system. Figure 7 shows a roadmap it is composed of curves and line segments. The system also allows user to add delay time and speed value for a group of line or curve segments. The user can add introduction information for the VGTags by fixing VGTag and then editing information as shown in figure 8. It is similar to the case of interested objects, the introduction information of these objects can be added by selecting the object of interests and editing information for it as illustrated in figure 9.

5.2 Access a Virtual Tour

Figure 10 is a screenshot of adaptation server for displaying the city model through bird's eye viewing. Figure 11 is a screenshot of 3DViewer running on PDA device. In figure 11 – (a), Introduction information will be provided to visitor when he/she selects the building that is the National Museum of Korea. In figure 11 – (b), the introduction information is adaptively provided to visitor when he/she is nearby the VGTag. The introduction information describes about the National Museum of Natural History.

Figure 12 and figure 13 are screenshots of 3DViewer running on PC. The introduction information is provided to visitor when he/she selects the object (see figure 12). During tour time, introduction information will be adaptively provided to visitor when he/she walks nearby the VGTag as shown in figure 13.

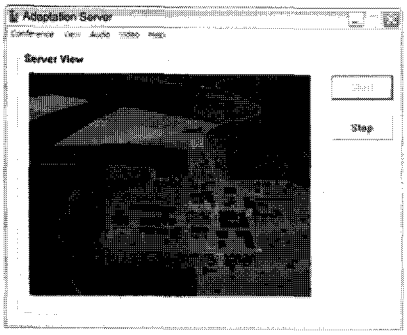
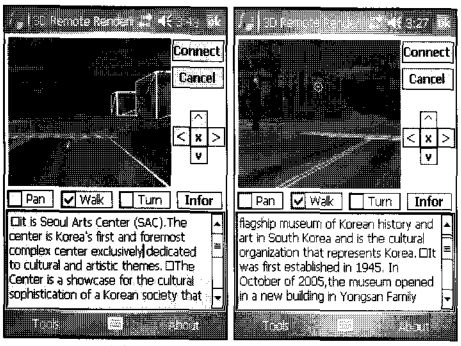


Fig. 10. A screenshot of the adaptation server.



(a) (b)

Fig. 11. 3DViewer running on a PDA device.

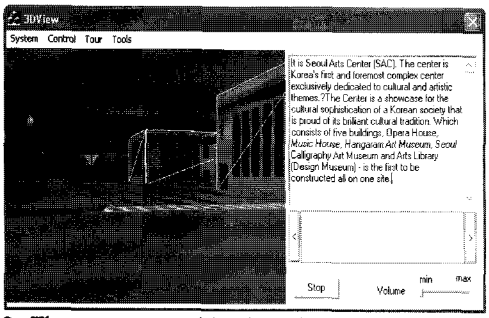


Fig. 12. The system provides introduction information when user selects building of interests.

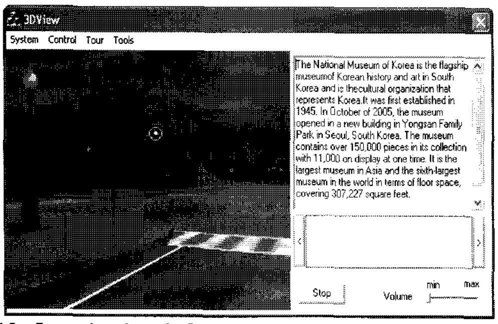


Fig. 13. Introduction information is provided to user during tour time.

VI. CONCLUSION

In this paper, we have presented a general framework for a virtual tourist system. The system supports immersive 3D graphics contents and relevant introduction information according to the interactions, location of the user in the 3D virtual environment. We have also proposed a model of virtual tour information based on the roadmap, the system of VGTags and then interested objects accompanied with introduction information for each 3D virtual environment. The context information service for providing introduction information has also introduced.

To evaluate our solution, we have implemented a virtual tourist system that is composed of an adaptation server, a 3DViewer, and a design-tool. The adaptation server and 3DViewer have been implemented based on our proposed client-server graphics adaptation framework [31]. The 3DViewer was specially developed for both PCs and PDAs. The design-tool was implemented for designing and managing the virtual tour information. We have experimented for designing a virtual tour through a 3D graphics model (city model) [32] and have tested for accessing the virtual tours using the 3DViewer running on PCs and PDAs.

ACKNOWLEDGMENTS

This work was also partly supported by the Korea Research Foundation Grant funded by the Korea Government (MOEHRD, Basic Research Promotion Fund) (KRF-04-2-74). This work was also partly supported by Seoul R&D Program.

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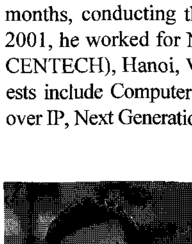

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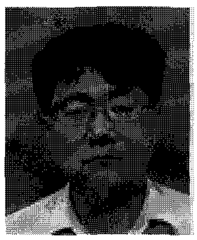

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