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Responsive Multimedia System (RMS) for Personalized Storytelling

Youngho Lee, Sejin Oh, Youngmin Park, Woontack Woo

***Abstract*— In this paper, we propose a novel interactive storytelling system which is called Responsive Multimedia System. The proposed system is composed of ARTable (tabletop tangible user interface), vr-UCAM (a unified Context-aware Application Model for Virtual Environments) and VEManager (Virtual Environment Manager). We adopt an interactive viewer, control object, vision-based camera tracker into ARTable. We also apply vr-UCAM to acquire information from VE, to process that information and to decide actions of virtual objects. Finally, we make the VEManager control the responses of virtual objects such as virtual characters, virtual camera, and virtual weather, according to the decision of vr-UCAM. The proposed RMS provides conventional user interface by utilizing ARTable which has both input and output display. RMS also provides adaptive responses of a user interface and virtual objects by utilizing user-centric context which is managed by vr-UCAM. Moreover, it gives us dramatic scene by managing virtual characters, virtual weather, and virtual camera. To demonstrate the effectiveness of the proposed approach, we applied it to an interactive storytelling application. According to the experimental results, we observed that the combination of virtual reality technology and context-aware computing could be promising technologies that enables users to experience a personalized interactive story. Therefore, we expect that the proposed system can play an important role in interactive storytelling applications such as education, entertainment, games, etc.**

Index Terms*— Context-awareness, Tangible User Interface, Interactive Storytelling, Personalized story

I. Introduction

With the rapid development of virtual reality and artificial intelligence technologies, entertainment computing industry has been popularized during the last decade. Nowadays, it is common for users to interact with virtual environment in various kinds of application areas including simulation, training, education and games. In this regard, many interactive storytelling systems have been developed in various types to show its effectiveness from desktop systems to large scale CAVE-like systems.

The representative examples were KidsRoom, NICE, and Larsen and Petersen's (1999) storytelling environment [1]. They combined the physical and the virtual world into interactive narrative play space. Ishii who recognized a seam between real and virtual environment, proposed Tangible User Interface (TUI) and demonstrated various types of interactive storytelling interfaces[2]. However, people want to tell a personal story rather than to play recorded stories. Thus personal storytelling system such as StoryMat and PETS were proposed based on Ishii's concept. It utilized an audience's personal information such as name, preference to unfold story. Even though they reflected user's information to story, it was hard to give high-level interactivity. So, A. Pavia suggested SenToy which was doll-type TUI[3]. She showed successful demonstration which acquires users' emotional activities. However, their interfaces didn't show feedback which can help users to utilize that interfaces. Moreover, these systems reduce user's interest because they only show same responses without considering users' preference. Including SenToy, most systems didn't consider a difference among individuals. They also don't consider about controlling of virtual objects, such as virtual characters, virtual weather, and virtual camera which are important to show a scene when we make interactive storytelling system..

We present Responsive Multimedia System (RMS) for interactive storytelling with user centric context. It consists of three key components; table type tangible users interface (ARTable), a Unified Context-aware Application Model for Virtual Environments (vr-UCAM), and virtual environment manager (VEManager)[4]. ARTable allows users to interact with virtual environments through human's senses by utilizing tangible and vision-based interfaces. vr-UCAM utilized to decides suitable reactions based on multi-modal input from ARTable. Finally, VEManager executes a decision of vr-UCAM and controls a sequence of actions of virtual objects in VE.

From the proposed system, users can interact with VE intuitively since we adopt daily-life interaction on ARTable and we can change ARTable according to a user's interaction and story. Moreover, users can experience a personalized story in which actions of virtual objects, interaction level and scene of VE are reorganized and adjusted according to a user's profile and preference. It also generates dynamic scene by controlling virtual characters, virtual weather, and virtual camera. Consequently, we can provide conventional user interface, personalized story, and dramatic scene. To demonstrate usefulness of the proposed system, we implemented a virtual

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heritage system which represents legend of *Unju Temple*[5][6][9][10].

This paper is organized as follows. In Section 2, we describe detailed components of RMS. In Section 3, seamless integration of RMS is explained. In Section 4, we show implementation of the heritage system. In Section 5, we present experimental results. Finally, the conclusions and future work are presented in Section 6.

II. OVERVIEW OF RESPONSIVE MULTIMEDIA SYSTEM

Out proposed RMS consists of three key components; a vision-based table-type tangible user interface (ARTable), a Unified Context-aware Application Model for Virtual Environments (vr-UCAM), and virtual environment manager (VEManager).

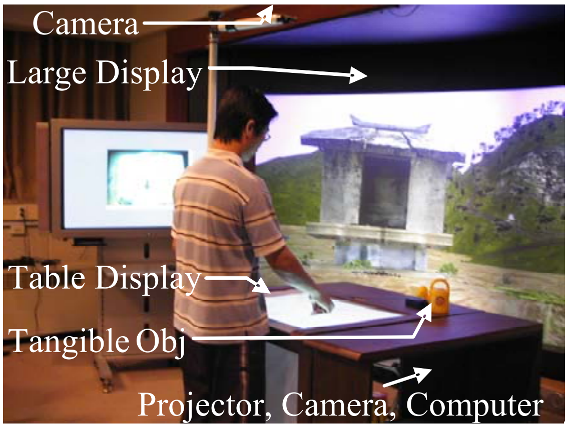

Fig. 1 Responsive Multimedia System.

A. ARTable: Table-type Vision-based Tangible User Interface

We design a table-type vision-based tangible user interface for intuitive and personalized user interaction. It is consists of table frame, camera tracker, interactive viewer, and control object[7]. The table frame has a semi-transparent display screen. The screen displays interactive viewer on the screen. Since it is semi-transparent, the control object put on the screen is tracked by camera tracker which is under the table. Interactive viewer displays images which can be selected by application designer. Camera tracker finds out the position of control objects which is put on the screen. Control object has familiar shape such as doll, toy, etc. We attach AR-marker below the control object.

In ARTable, we process several steps to decide actions. Firstly, camera tracker calculates x- and y- coordinate of a control object after getting images in real-time from below camera. We compare this coordinate with internal state, such as past actions and current condition to run events. In next step, we decide actions of interactive viewer and deliver the result to VE through the network.

Fig. 2 ARTable. A user puts the control object on the storymap.

We design the user interaction by combining basic control object movement and interactive viewer. ARTable allows users to move control object on the surface of table. Below the object, we attach AR-marker, so that the camera tracker can tracks the 3D position of control object. From this configuration, we can do daily-life interaction which can occur on the table. For example, we can do navigation. Users watch geometric map which is shown by interactive viewer and put the control object on the specific location on the map where we want to see. Or we can input or select information by putting control object on the button which is shown on the table.

B. Context-awareness and application with vr-UCAM

We utilize vr-UCAM as a framework to provide personalized interactive story[4]. Vr-UCAM is composed of vrSensor and vrService. It has the same architecture with ubi-UCAM and supports seamless interaction between real and virtual environment by sharing user-centric context. Thus, based on vr-UCAM, we can compose tangible user interface and complex virtual environments where includes various virtual objects. vrSensor and vrService are distributed independently and they share user-centric context through the distributed network.

We apply vrSensor to context-aware for personalized interface, events and interaction. Context is represented as a form of 4W1H. A user's preference and profile is acquired by vrSensor through the user interface. It is categorized explicit command and implicit command. Explicit command is direct actions which can be interpreted a specific command easily and implicit command is inferred command from a user's actions which cannot be interpreted easily. We define sensing area and features to acquire from the changes in contents. That is to say, when specific events have been occurred, vrSensor determine the situation by given conditional statements and multicast it as a form of 4W1H over the network.

The vrService receives a context from the vrSensor and utilizes a given context to manage user interface reconfiguration, events selection, and user interaction level to provide personalized story. First, we apply it to recomposes a user interface and provides personalized user interface. Second, we apply it to changes a sequence of events to compose personalized event sequences. At last, we apply it to optimize the level of user interaction according to a user's profile. For example, when a novice person such as a child tries to use our system, we simplify user interface, add supplementary explanation, and make a short story.

C. Virtual Environment Manager (VEManager)

VEManager manages start, pause, and stop of virtual objects, such as virtual camera, changes of weather in VE, and animated characters to show a scene according to the story. It is important to manage appropriate scenes in interactive storytelling with movies. However, in the interactive storytelling system, the virtual objects follow not only director's intension but also a user's intension. In this aspect, we need to control virtual objects for personalized scene by reflecting user-centric context.

We define virtual objects as virtual characters, virtual weather and virtual camera. We describe Virtual object's actions based on the finite state machine. For example, let's assume that there are a tree which has three states; standing up (no moving), moving by wind, and blooming flower. We change the states according to the decision of vr-UCAM.

We describe the animated characters and virtual weather with state and transition condition. The state means the possible actions of virtual objects. The transition condition means the condition to change state from current to next state. It can be defined $C = < P, T, E >$, where P is a set of states, T is a set of transitions, and E is a set of arrows from P to P. We can mark the initial state of virtual objects as $m = [m(p_1), m(p_2), \cdots, m(p_n)]$. Starting from initial mark m, if a transition condition is satisfied, we select next states or actions. This description is inserted in service provider in vr-UCAM.

The virtual camera position is decided by processing three steps. First, we determine the position based on geometric and physical information given by 3D models. Second, we adjust the position by applying information from author's story line. For example, we can assign virtual camera coordinates for the specific events. Finally, we refer user's profile and preference. In each step, we calculate a matrix.

III. Seamless Integration of User Interface, Context-Aware Application Model, and Virtual Scene

A. User-Centric Context and its application

The context for an interactive Storytelling is categorized with explicit context and implicit context. Explicit context indicates a direct command such as gesture, pressing button. Implicit context means personal information or preference. The context supports seamless connection between RE and VE by exploiting as a form of 5W1H[8]. Moreover, we apply two methods to extract context; WPS (Wearable Personal Station) for implicit context, sensors for explicit context. WPS manages the user's needs and preferences. When we want to acquire context by sensors, it depends on target and the sensor type. For example, if we use a vision interface, we can get the user's gesture or position by processing video frames.

Context is responsible for unfolding the story with sequences of events, execution of events, interaction level, and for changes in VE. Firstly, we can compose different event sequences according to the user's personal information. Secondly, we can offer different events, e.g., if someone selects 'good' mode, he can watch blooming trees. Or others can watch shaking trees by wind. Thirdly, we can also adjust proper interaction level according to users. For example, if a young child experiences a virtual story, we need to restrict degree of freedom of user interface since the child does wring actions as he/she wants. However, if an adult experience a virtual story, we can recommend proper actions for building a story. Finally, we provide users with personalized VE. For example, weather and lightning can be changed according to the user's preference.

B. Seamless Interaction: vr-UCAM

We assume that an interactive storytelling is achieved by seamless interaction between users, real and virtual environments. From this point of view, we divide the environments into four parts: users, surroundings, virtual objects and virtual surroundings. Story is unfolded with collaboration of users, ARTable (surroundings) in real world and virtual objects, virtual surroundings in VE. As shown in Fig. 3, users, ARTable and VE are connected as an input and output relationship by using vr-UCAM. For instance, multimodal tangible user interface, e.g., dolls and watch, are connected to virtual object (avatars) and time of day in VE. So, when users manipulate user interface, the results are displayed in the VE. On the other hand, an action of virtual object in VE affects states of user interface.

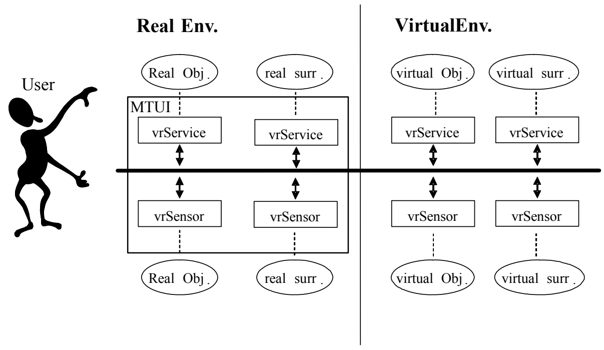

Fig. 3 Relationship between a user, RE and VE. A user interacts with tangible interface in real environment.

vr-UCAM is a framework for designing context-aware applications in virtual environments. It is focused on implementation of intelligent objects which response according to the user's context. To extract the user's context, actual or virtual sensors acquire raw signal, and then generate the preliminary context which only contains limited information according to the sensor's ability. Furthermore, virtual objects and virtual surroundings integrate several contexts from sensors, and determine proper responses. That is, through acquisition, delivery, and processing step, they understand not only explicit input but also implicit input of users. After understanding the user's intention, the applications decide and show pertinent responses.

IV. Implementation

To design the introduced virtual story, we processed following steps. At first, we assigned events on the seven specific locations. From these events, we designed virtual objects and MTUI which interact with users. Moreover, vrSensor and vrService were implemented and attached to the objects and surroundings. Table 1 shows the context list which can be extracted from implemented vrSensors in the proposed RMS [5]. Table 2 shows the actions of vrSensor and vrService which was implemented in this system.

Table 1 Context List.

	Context	Sensor
Real Env.	Coordinate of object in Table	Camera Tracking System
	Time of RE	Time sensor
	Weather of RE	Weather caster or simulator
Virtual Env.	Location of VE	Location sensor in VE
User	Age, gender	PDA
	Preference (animals, color, weather)	User's selection on Table display and tangible objects

Table 2 Actions of vrSensor and vrService.

	Name	Actions
vrSensor	vrController	Senses a user's gesture from motion of object
	vrWeatherforecaster	Detects current weather state
	vrTimer	Acquires current time
	vrLocationSensor	Senses location of a user's avatar in virtual Unju
vrService	vrViewer	Displays maps or pictures on ARTABLE
	vrNavagator	Changes the camera path
	vrDoseon	Appears or disappears when he want.
	vrMaae	Begins to Ruin according to time.
	vrPlant	Grows and Blooms
	vrWeather	Changes the color of sky, location of sun, fog in VE
	vrSound	Generates specific sounds

V. EXPERIMENTAL RESULTS

We made up questions to 48 persons who graduate university. Their interest research areas were ubiquitous computing, user interface, virtual reality. About ARTable, 37.5% persons estimated 'very easy' to use. However, 50% persons unsatisfied. They pointed out that the ARTable has a possibility enough to support a natural user interaction; however, we need to improve it at the commercial product level. 39.5 % persons are interest in personalized story. They put on premium on personalized story which reflects their background knowledge and preference. In addition, participants would like to talk with virtual characters. It will be the future work.

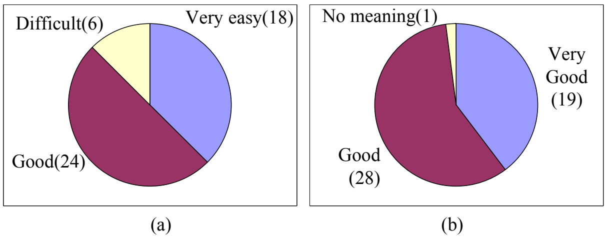

Fig. 4 Survey results. (a) ARTable usability test, (b) opinions on personalized storytelling.

VI. CONCLUSION

In this paper, we presented Responsive Multimedia System (RMS) for interactive storytelling. In our proposed approach, users can interact with VE intuitively through implemented tangible user interfaces. Moreover, users can experience a personalized story in which events, interaction level and scene of VE are reorganized and adjusted according to a user's profile and preference. Consequently, we can control balance of interactivity and narration by changing interactive StoryMap according to the user's profile. In the future, we have plans to find evaluation method to improve our storytelling approach. In addition, we need to develop authorized tools to make contents and stories with RMS. Furthermore, we will apply the concept of artificial life for the virtual object.

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