Creating Memorable Experiences in Virtual Reality: Theory of Its Processes and Preliminary Eye-Tracking Study using Omnidirectional Movies with Audio-Guide

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***Abstract*—Reality is the true situation which consists of a set of things that are actually experienced. Human beings live in the environment filled with artifacts, part of which is real and the rest is virtual. The purpose of this paper is to show how the perceptual-cognitive-motor processes along with the memory process of human beings result in memorable experiences. Since memory system is cumulative, any external stimuli that do not resonate with the existing memory are not real but virtual. However, repetitive experiences should strengthen its memory trace along with its associated memory which in turn makes the virtual change to the real. It is argued from the dual processing perspective necessary conditions for the memory system to work to make the virtual to the real by drawing preliminary results from a study that showed how omnidirectional movies in virtual reality augmented with audio-guide made the experience memorable by timely synchronization and integration of multi-modal information.**

***Keywords*-memorable experience; virtual reality; eye movements; omnidirectional movies; MHP/RT; multidimensional memory frames;**

I. Introduction

A. Continuous Cyclic Loop of Perception and Movement

What a human being does in every day life is an endless cyclic loop of "*perceive* physical and/or chemical stimuli in the external and internal environment" and "*perform* a motor action to cause changes in the internal and/or external environment." The left portion of Figure 1 illustrates this endless loop. Perception is a *parallel* process governed by the sensory nervous system in which multiple senses take part. On the other hand, motor movement is a *serial* process that is governed by the somatic nervous system. In-between the sensory nervous system and the somatic nervous system are interneurons that cross-link the two systems, whose activities, *cognitive processes*, define what will be carried out by the somatic nervous system for the given stimuli from multiple senses transmitted via the sensory nervous system.

What a human being does at a certain moment as the output of cognitive processes, i.e., an action, is represented as a pattern of activities of motor nerves. An action might be the one with short characteristic times of the order of a few hundred milli-seconds such as moving eye-balls to a next object to pay attention to, or with moderate characteristic times such as uttering a few words, or stepping towards an object to observe it more closely. The fact that one does a specific action at a certain moment should connote that one does not carry out the other actions that are doable. What he or she has done should cause some changes in the existing cross-links that memorize every past experience of this individual to update their structure, which in turn should affect the behavior of the cyclic loop in the future.

Relation to VR: Successful integration of virtual reality with real world perception, cognition, and motor movement processes should only be possible if the stimuli provided by virtual reality environment be seamlessly hooked onto the cyclic loop of perception, cognition, and motor movement.

B. Memory: Chain-Firing in the Nervous Memory System

Memory system is a cumulative and irreversible system: actions that have been selected and carried out have contributed to updating the structure of memory at the time the action was carried out. An action is selected and carried out within an acceptable time frame by *integrating* the activated network, which depends on the detailed environmental conditions in which the action should be carried out in *synchronous* with the changes of the environment.

Perception plays an important role for the development of the cyclic memory network. The memories are cross-linked each other and perceptual objects reside at the center of the cross-links. The perceptual system continuously monitors changes in the environment, and starting from the perceptual objects created while processing the environment, it fires the cyclic memory network. The firing continues and spreads in the network, i.e., chain-firing, as long as the perceptual objects last in the environment. The activated region of the network finally obtained as the result of the chain-firing is "the accessible memory region" at the moment.

What this process actually does is to pre-process the situation for the future by activating related memory regions beforehand. The origins of the chain-firing are continuous input from the current environment. In the situation with

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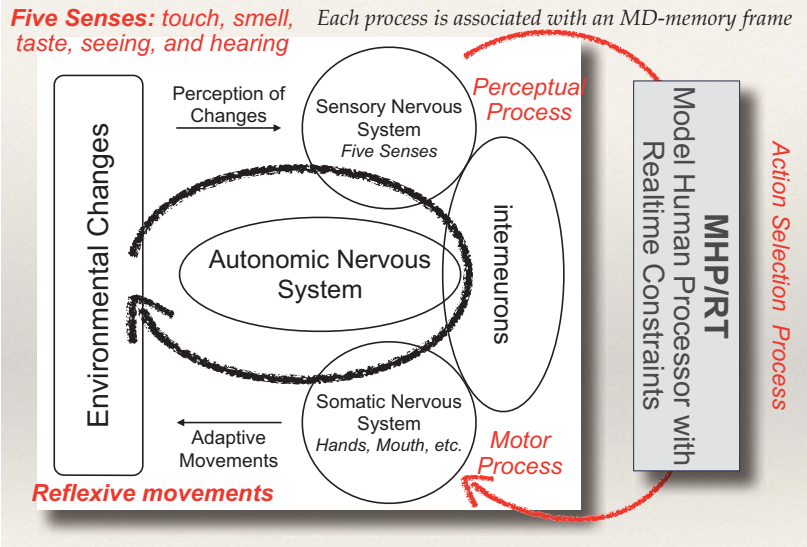


Figure 1. Continuous cyclic loop of perception and movement and its mapping on the theoretical construct of "MHP/RT and Multi-Dimensional memory frame." The left portion of this figure is a slightly modified version of the one adapted from [1].

severe realtime constraints, the activated region would be used with a high priority.

Relation to VR: Memory system resonates in response to the perception of environment via the five senses to make available the portion of the cross-links in the memory relevant to the perceived stimuli by activating the network, and the activation spreads along the network. Virtual environment is virtual: it may or may not resonate with the existing memory network that has been constructed via "real" experiences.

C. Outline of the Paper

This paper discusses multi-modal artifact design for satisfactory and memorable experience from the viewpoint of human being's perception-cognition-motor processes (PCM processes) and memory processes for utilization of the past memory and accumulation of the current experience on the basis of the theory of human action selection and memory in the context of human–computer interaction [2].

Section II describes a dual processing theory, MHP/RT [2], [3], that consists of the PCM processes along with the memory processes that continually develop as the PCM processes are carried out in the ever-changing environment, including the VR environment. Critical factors are identified that enable human beings experience virtual environments satisfactorily and memorable, which will be examined in Section III by having experimental participants view omnidirectional movies as a form of VR in various conditions to test the effect of audio-guide to form impressions. As the experiment was not comprehensive, only tentative conclusions are provided in Section V.

II. The Theory: Action Selection and Memory

The right portion of Figure 1 shows *Model Human Processor with Realtime Constraints (MHP/RT)*, which is a theoretical construct to model the cyclic process of action selection and memorization in which each process is associated with multi-dimensional memory frame.

A. Action Selection Theory: MHP/RT

To model continuous cyclic loop of perception and movement, constraints on behavioral processing are imposed by conscious and unconscious processes, and behavior must be synchronized with the ever-changing external and internal environments, which is a form of self-organization. Figure 2 illustrates MHP/RT and multi-dimensional memory frames as the realization of the theoretical construct shown in the right portion of Figure 1.

MHP/RT specifies behavior generation processes that include the autonomous perceptual system associated with sensory neurons and the autonomous motor system associated with motor neurons. Interneurons process the input from the perceptual system with the conscious decision making process or the unconscious automatic action selection process. Each process in behavior generation defined by MHP/RT is associated with a multi-dimensional memory frame. As such, behavior and memory are intimately connected with each other and the amount of the contents stored in memories are accumulated incrementally as the time goes by and the stored entities are strongly influenced by the detailed experience each individual has at each moment.

MHP/RT is an extension of dual processing theories, Two Minds, proposed by [4], which is capable of simulating decision making and action selection in daily life. Two

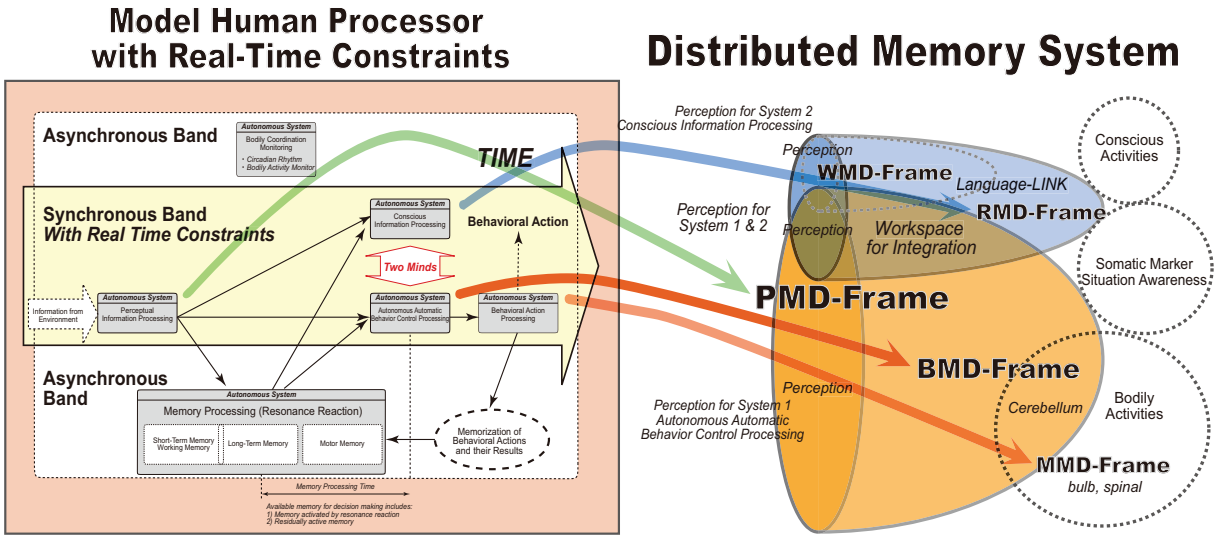


Figure 2. MHP/RT (Figure 3, [3]) and the distributed memory system.

Minds consists of unconscious processes, System 1, and conscious processes, System 2. System 1 is a fast feed-forward control process driven by the cerebellum and oriented toward immediate action. In contrast, System 2 is a very slow feedback control process driven by the cerebrum and oriented toward future action.

The left portion of Figure 2 shows the outline of MHP/RT. MHP/RT focuses on synchronization between System 1 and System 2 in the information flow from the perceptual system from the environment at the left end to the motor system at the right end. Output from the perceptual system is diverted into three paths, one path leads to the conscious process of System 2, the other leads to the unconscious process of System 1, and the last one leads to the memory system. Information in memory activated by the input from the environment becomes available to System 1 and 2. System 1 and 2 work in synchronous with each other but the memory process works asynchronously with System 1 and 2. The dotted oval shows the process of memorization of output from the motor process. These interactions between System 1 and 2, and memory are not seriously considered in the original Karhneman's Two Minds [4], [5].

B. Four-Processes and Time Constraints

At a particular time *before* an event, one engages in conscious and unconscious processes concerning the event to happen in the future. At a particular time *after* the event, one engages in conscious and unconscious processes concerning this event that has already happened in the past. What one can do before and after the event is strongly constrained by the Newell's time scale of human action [6]. System 2 carries out the processes at the time range from 10 seconds, whereas System 1 does those at the time range from a hundreds of milli seconds to a few seconds.

MHP/RT works in one of four different modes. Two are before the event in which MHP/RT uses memory and the other two are after the event in which it modifies memory:

- System 2 Before Mode: MHP/RT consciously uses memory before the event for anticipating the future event which takes relatively long time.
- System 1 Before Mode: it unconsciously uses memory just before the event, say 100 milli seconds before the event for automatic preparation for the future event.
- System 1 After Mode: it unconsciously tunes the current network connections related to the past event for better performance for the same event in the future.
- System 2 After Mode: it consciously reflects on the past event resulting in structural changes in memory.

C. How Memory is Constructed: System1 & 2 After Mode

Memory is created via working of autonomous nervous system that operates along the information flow from the sensory nervous system to somatic nervous system via interneurons under the time constraints that would reflect the environmental conditions at the time of operation. We can derive structural features by considering the fact that each autonomous system in MHP/RT has its own memory; each memory records the traces of its working over time:

1) Collecting information from the environment via perceptual sensors,
2) Integrating and segmenting the collected information, centering on visually collected objects, and
3) Continuing these processes until the necessary objects to live in the environment are obtained.

These objects are then used independently in Systems 1 and System 2 of Two Minds, and memorized after integrating

related entities associated with each system.

Due to the limitation of the brain's processing capability, the range of integration is limited; therefore, System 1 memory and System 2 memory should differ. However, they could share objects originating from perceptual sensors. Thus, when objects that are the result of the just-finished integration and segmentation are processed in the next cycle, representation of the objects may serve as the common elements to combine the System 1 memory and the System 2 memory to form an inter-system memory. We call this memory the Multi-Dimensional (MD) -memory frame.

D. Multi-Dimensional Memory Frames

Each autonomous system in MHP/RT has its own memory as a multi-dimensional memory frame; each memory system records the traces of its working over time. As the main modules, MHP/RT consists of perceptual system, conscious processing system, and unconscious processing system. The right portion of Figure 2 illustrates memory systems associated with these main modules. In addition, memories are added that are created by integrating individual memories associated with System 1 and System 2, respectively.

E. Synchronization and Integration in Virtual Environment

As described in the previous subsections, the PCM processes are intensely coupled with the external environment via the memory network, when planning what to do consciously, tuning to-be-performed actions unconsciously, tuning the existing network connection unconsciously, and updating and/or restructuring the existing network consciously. Any virtual environments do not have reality. Therefore, any behaviors or experiences to be carried out in those environments require some efforts of the conscious and unconscious processes to develop memory networks that would respond to them if they are to be carried out in a similar way as they work for real environments.

Stimuli from a virtual environment are artificial and therefore created through some calculation. They are processed by the dual process of human beings equipped with memory system with some constraints as described in Section II. The constraints are from the time dimension as described in Section II-B and from the contents dimension as described in Section II-D: the former is about how the input stream of information from the environment is synchronized with the inner dual processes, and the latter is about how the contents involved in the input stimuli resonate and are integrated with the contents that constitute the existing memory network [7].

This paper focuses on synchronization and integration of visual and auditory stimuli provided by a virtual environment. Visual stimuli are provided as omnidirectional movie to which participants have some freedom in information gathering activity. Where to look at is at their disposal. When audio-guide is provided for explanation of the visual content, it may or may not be integrated with the then-activated memory network depending on the timing of provision. A necessary condition for the success of the integration would be simultaneous activation of PMD (Perceptual Multi-Dimensional-frame) triggered by sensory information and WMD (Word Multi-Dimensional-frame) triggered by the language in the audio-guide. If audio-guide in language form is provided timely within the characteristic duration of chain-firing before the activation fade away, the experience in virtual environment would be integrated with the verbal information, which would then be stored in long-term memory to established a pattern of network. This is the matter of synchronization. This in turn is made available for later opportunities. It will be activated triggered by a specific set of cues, or words, that are stored in long-term memory. Otherwise the past memory will be hard to retrieve.

III. Experiment

A. Purpose

The way how visual information processing and audio information processing are coordinated in virtual environments determines the way how the memory is created and/or updated. We have conducted a feasibility study to develop an experimental framework to investigate this issue. The virtual environment is created as an omnidirectional video. While a participant was appreciating the video at his/her disposal, an intervention in the form of audio-guide was carried out which should affect the memorization process of the participant with varying degrees of significance depending on the contents and timing, as suggested by the theory. The degrees of influence would be measured by having the participant recall the experience afterward.

B. Method

Three conditions were considered:

1) No audio-guide learning condition (NL): no audio-guide is provided, a control for the other two conditions in which audio-guides are provided.
2) Preparatory learning condition (PL): the audio-guide for the artifact is provided *before* the movie starts. In this condition, it is assumed that the contents of the audio-guide are integrated with the pre-existing memory network of the participant to be resonated afterwards while viewing the movie, part of which would be memorized asynchronously and made recallable after the entire session of viewing four movies.
3) Simultaneous learning condition (SL): the audio-guide is provided 50 seconds *after* the movie starts. In this condition, it is assumed that the contents of the audio-guide are integrated synchronously as they are read aloud with the activated part of memory network of the participant, part of which would be memorized and made recallable after the entire session.

The experiment was conducted from 17 through 19 of October, 2016, at the digital dome theater of Wakayama

University. The number of participants was eleven in the ages of their twenties. Four omnidirectional movies were created for the artworks at an art field and respective audio-guides were recorded. Each participant was provided with four movies with one of the above conditions. After viewing four movies a questionnaire survey was carried out for investigating the participant's memory of the experience.

C. Materials

Detailed descriptions of the two of four movies and their associated audio-guides are given below. Preparatory analyses are described for these two materials.

1) Movies: The movies used for the experiment were recorded at the field of "Echigo-Tsumari Art Triennale[1]" by using an omnidirectional camera mounted on a mobility scooter which moves at the speed of 1km/h, which approximates the walking speed of the visitors to the Echigo-Tsumari Art Triennale when appreciating the artworks displayed in the field. Two artworks selected for the analysis of this paper were recorded by the omnidirectional camera mounted on the mobility scooter:

- Movie 1: The mobility scooter starts at a point on a lane that leads to the artwork lane in seven seconds, and advances the artwork lane for three minutes. The artwork, "Kakula Kulkul at Tsumari", is a set of windmills made of bamboo, folkcraft of Bali where the artist of this artwork was born, installed on the both sides of the lane. The windmills make a sound in the wind. Figure 3 shows the scenes from Movie 1 for the artwork "Kakula Kulkul at Tsumari." The center of the figure corresponds to the zenith, and the bottom-center and the top-center correspond to the forward and backward directions, respectively.
- Movie 2: The title of the artwork is "Set North for Japan ($74°33'2''$)." It is displayed alongside a road. The mobility scooter starts at the point where it takes about 30 seconds before the artwork is visible. It takes another 20 seconds for the scooter to reach the closest point on the road to the artwork. At this point, the scooter stays about 60 seconds. In addition to the artwork, there is a torii, a traditional Japanese gate most commonly found at the entrance of a Shinto shrine, just ahead of the scooter overarching the road. The scooter restarts after a 60-second stay and passes under the torii. Figure 4 shows the scenes from Movie 2 for the artwork "Set North for Japan ($74°33'2''$)."

2) Audio-Guides: Audio-guides for the selected artworks were created by having a paid collaborator read aloud the texts that provide brief descriptions of the respective artworks found on the official homepage of Echigo-Tsumari Art Triennale.

- Audio-Guide 1 (Kakula Kulkul at Tsumari): The length was 54 seconds. It started 30 seconds after the onset of Movie 1. The English translation of the audio-guide is as follows:

  The artwork originally exhibited in 2006 was remade with a new arrangement. "Kakula Kulkul" is a windmill made of bamboo, which constitutes a part of familiar scenery of the place of the artist's birth, the island of Bali. It is a folk art that a farmer places on the rice field around the harvest time for thanking the God for crops. A comfortable sound made by a line of bamboo in wind encompasses visitors along with the scent of rice fields and flowers. This artwork connects two places, the island of Bali and Tsumari, where living is based on agriculture and represents universal grace for harvest.
- Audio-Guide 2 (Set North for Japan ($74°33'2''$)): The length was 22 seconds. It started 55 seconds after the onset of Movie 2 while the mobility scooter was still. The English translation of the audio-guide is as follows:

  The house of the artist in London is "moved" to Tsumari by a parallel translation: its structure is kept in its real sizes, and its orientations in London are also kept in Tsunami as well. It's an attempt to relate two places distant from each other spatially, not only physically but also culturally.

D. Apparatus and Viewing Behavior Data

Viewing behavior of the participants were recorded by using a wearable eye tracker (Tobii Pro Glasses 2) at a sampling rate of 30 Hz. The resolution of the scene camera was 1920×1080. Each gaze point was recorded as a point on the coordinate system of the scene camera.

E. Questionnaire

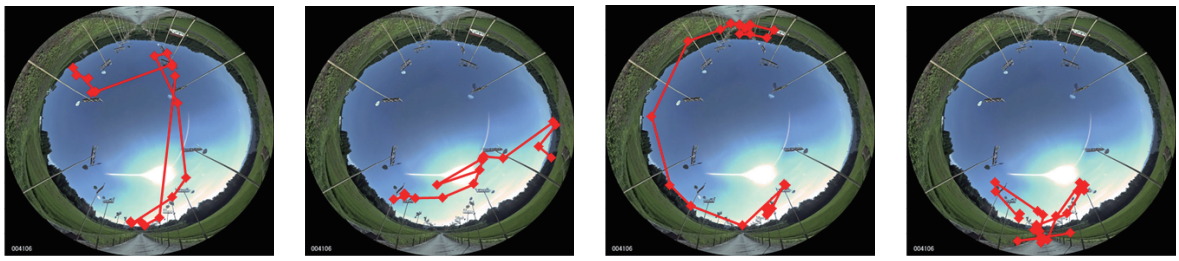
A questionnaire was prepared for investigating the contents of memory of the participant after viewing four movies. More specifically, the participants were asked to answer impressions of the movies in terms of the names of objects in the respective movies and a plausible theme of the respective movies. For the most impressive movie, the participants were asked to write freely about it.

IV. Results

A. Viewing Behavior

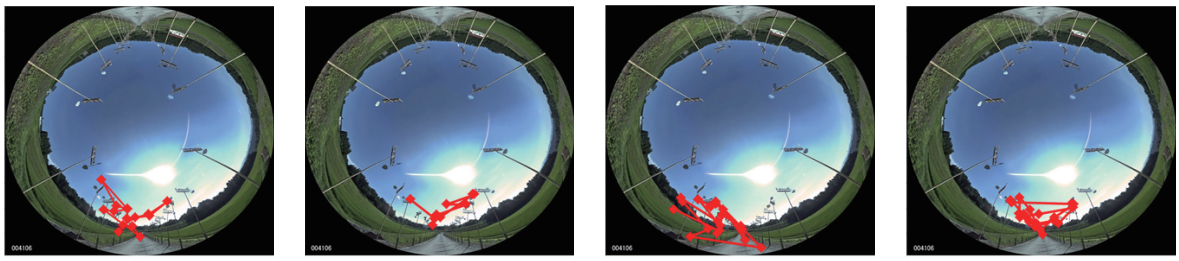
1) Movie 1: Kakula Kulkul at Tsumari: Figure 3 shows the trajectories of eye movements in the time frame of 73 seconds to 79 seconds from the beginning of the movie. The audio-guide started 30 seconds after the beginning of the movie with the length of 54 seconds (ended at 84 seconds from the start).

[1]Echigo-Tsumari Art Triennale is one of the largest art festivals in the world and is held once every three years in the Echigo-Tsumari region since 2000. The Triennale provides an opportunity to present projects and initiatives developed in the Echigo-Tsumari Art Field. (adapted from http://www.echigo-tsumari.jp/eng/about/overview/)



(a) (b) (c) (d)

Movie 1: Participants' eye-movement trajectories in the PL condition.



(e) (f) (g) (h)

Movie 1: Participants' eye-movement trajectories in the SL condition.

Figure 3. Eye movement trajectories for Movie 1 during the period of 73 through 79 seconds from the start of the movie. The figures at the top row are from the participants in the preparatory audio-guide learning condition. Those at the bottom row are from the participants in the simultaneous audio-guide learning condition. During this time frame, they were hearing the last portion of the audio-guide ending at 84 seconds.

Four figures at the top row are those from the PL condition, and four at the bottom row from the SL condition. At a glance, except for (d) in the PL condition, the trajectories spread in the screen (a) back and forth, (b) right and left, and (c) circular. On the other hand, (d) in the PL condition and all trajectories in the SL condition, the trajectories concentrated on the windmills ahead.

2) Movie 2: Set North for Japan ($74°33'2''$)*:* Figure 4 shows the trajectories of eye movements in the time frame of 70 seconds to 77 seconds from the beginning of the movie. The movie stayed still during this time frame. This time frame corresponds to the last one third of the duration of the audio-guide presentation in the SL condition.

Three figures at the top row are those from the PL condition, and four at the bottom row from the SL condition. It is observed that the trajectories from PL are centered on the torii which is at the bottom of the figure or in the direction ahead in the planetarium dome, on the other hand those from SL are roughly classified in three types. The first one at the left end shows that the trajectory of eye movements of the participant concentrated on the artwork; the second and the fourth ones look similar. The participants concentrated on the torii during this time frame of audio-guide presentation. The third one shows a transitional trajectory from the artwork to the torii.

Table I
RESPONSES FROM PARTICIPANTS AFTER VIEWING FOUR MOVIES TO THE QUESTIONNAIRE ASKING MEMORY OF MOVIE 1 AND MOVIE 2.

Movie 1: Kakula Kulkul at Tsumari

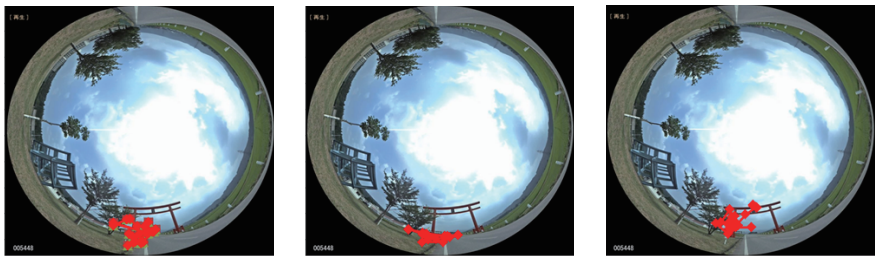
	Responses	
	Present in the audio-guide	Absent in the audio-guide
PL	bamboo (3), windmill (2), rice field (2), the island of Bali (1), folk art (1), visitors (1)	road (2), hill (1), welcome(1), children in the back (1), a married couple (1) , river, sky, scenery of farm (1)
SL	bamboo (2), rice field (2), comfortable sound (1), thanking the God for crops (1)	sky (1), nature (1), instrument (1), hill (1), car (1), well (1), forest (1)

Movie 2: Set North for Japan ($74°33'2''$)

	Responses	
	Present in the audio-guide	Absent in the audio-guide
PL	places distant from each other spatially (1)	torii (3), car (3), flag for sayety drive (1), sky (1), school (1), lane (2), UK (1), object of modern art in blue, art
SL	cubic object (1), connects to London spatially (1), reproduces the orientation as well (1)	torii (4), car (2), sound of car passing (2), paved road (1), rice field (1), nature (1), contrast between scenery and red (1)

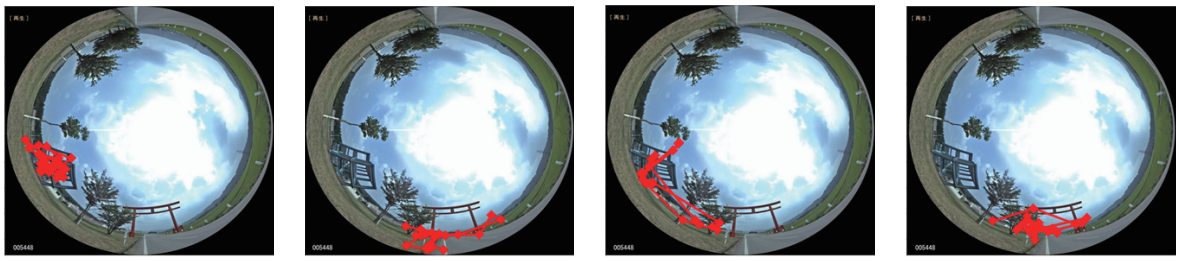
B. Memory

Table I shows the responses of the participants for the questionnaire to investigate the impressions of the expe-



(a) (b) (c)

Movie 2: Participants' eye-movement trajectories in the PL condition.



(d) (e) (f) (g)

Movie 2: Participants' eye-movement trajectories in the SL condition.

Figure 4. Eye movement trajectories for Movie 2 during the period of 70 through 77 seconds from the start of the movie. The figures at the top row are from the participants in the preparatory audio-guide learning condition. Those at the bottom row are from the participants in the simultaneous audio-guide learning condition. During this time frame, they were hearing the last one third of the audio-guide for this artwork.

rience. The questionnaire asked the names of objects and plausible themes of the respective movies. In order to see if there are differences between the two presentation conditions of the audio-guide, and between Movie 1 and Movie 2, the responses are classified into four categories: 1) those present in the audio-guide provided before the movie started (PL), 2) those absent in the audio-guide provided before the movie started (PL), 3) those present in the audio-guide provided while the movie was running (SL), and 4) those absent in the audio-guide provided while the movie was running (SL).

1) Movie 1: Kakula Kulkul at Tsumari: There seems few differences between two audio-guide presentation conditions. The numbers of keywords in the respective conditions were large. The feature of the movie was that the artwork is a set of windmills placed on the both sides of a lane with continuous sound. The duration of the external stimuli, not only visual but also auditory, was long. Therefore it should have been used as the triggers for resonating relevant portion of existing memory to form impression. An important feature of this artwork from the viewpoint of chain-firing is that the stimuli from the artwork had been continuously input to the perceptual system of the participants. Chain-firing would have continued as far as they had been seeing the windmills and hearing their sound.

In the PL condition, the participants who had heard the explanation of the artwork before the movie started would have had some anticipation concerning what would happen in the near future. This is the process that would have happened in "System 2 before Mode" as described in Section II-B. The memory created through this mode would have resided in memory while the participants had been experiencing the Movie 1. Chain-firing initiated from the continuous shower of visual and auditory stimuli would have had reached the memory of the anticipation, which would then have created a memory of this experience in "System 1 after Mode" while viewing the windmills and hearing the sound and in "System 2 after Mode" after finishing Movie 1 by reflecting on the experience. These processes would have created strong memories of the experience.

In the SL condition, the scenario just described for the participants' perceptual and cognitive processes in the PL condition would need to be changed slightly. The participants in this condition would have activated the region of memory that was related with the visual stimuli, i.e., windmills, and the sound created by them. The perceptual stimuli had been continuously provided, and therefore the memory region must have been kept active. At that time, they heard the audio-guide, whose contents had initiated chain-firing to reach the already-activated memory region related with the windmills and their sound.

In both conditions, memory activation initiated by the external stimuli in the network that is structured in the form of MD-frames is coupled with the four processes of MHP/RT to cause memorable experience in the virtual reality environment created by the omnidirectional movie.

2) Movie 2: Set North for Japan ($74°33'2''$): On the other hand, there seems to be qualitative differences in the nature of responses for this movie. The responses present in the audio-guide from the SL condition were more concrete than the ones from the PL condition. The artwork in Movie 2 was localized at a place alongside the road, which was referred to by using the words "house" and "structure."

A convenient simulation of chain-firing would suggest that the active regions of memory initiated from the audio-guide would overlap little with the active regions of memory initiated from the visual information obtained by eye gazes. However, the familiar object, torii, which overarched the road and painted in red, would be visually salient. A series of chain-firing initiated from visual input of the red, distinguished object would activate its symbolic representation, torii, which resides in the participants' existing memory with relatively strong concept, because it is very familiar concept from the viewpoint of Japanese participants.

V. Conclusion

This paper focused on the issue how the stimuli in the virtual environment should be integrated with the existing memory network to form memorable experience with virtual reality. MHP/RT and its associated memory structure, MD-frames, were introduced as a dual processing theory that is capable of simulating human beings daily action selection processes in the ever-changing environment. It was expected that experience in a virtual reality environment could be memorable if "System 2 After Mode" worked appropriately. The preliminary study using omnidirectional movie to have the participants experience virtual reality experience was conducted, in which memory processes were controlled by providing audio-guide in two timings, before the movie started and during the movie. It was found that the model-based simulation successfully provided plausible explanation for the experimental results of participants' gaze trajectories and report afterwards that would show the memory of the experience.

The endless cycle of turning virtual to real would continue starting from one's birth and ends at one's death. Any artifacts condense past experiences of mankind and manifest themselves as virtual for a person at the first time. However, once they are integrated into one's long-term memory they turn to reality [8]. The first step of formation of a cyclic network of relations between perceptual development and motor development [9] is to segment out *an object that appears as virtual* by detecting edges by using perceptual information represented in multiple dimensions including haptic cognition, visual cognition, and so on, which is superficial but information density is very high. The characteristics of the object are specified through its use in behavior, which is serial in nature and therefore information density is low. Once a word symbol is attached to the object, it works as a pointer to the object. At this time, the object in virtual turns to *an object as perceived as real*. Since a symbol connotes the use context of the object it represents, the network of symbols that will be constructed in the future is inevitably influenced by existing symbols.

The theory-based simulation shown in this paper would provide a firm basis for designing memorable virtual reality experience [7]. The simulation will include human beings' responses, which are chain-firing at the lowest level and making association with language at the highest level of consciousness. Virtual reality is artifact and therefore it requires designing. At the outset, it is virtual and requires the PCM and memory processes to integrate it with reality stored as networks of memories, which would make the experience as part of reality. The theory-based simulation approach would be an effective approach to design virtual reality environments that should go with human beings appropriately, which should not prevent us from natural development of perceptual-cognitive-motor and memory processes.

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