Animal Observation Support System based on Body Movements: Hunting with Animals in Virtual Environment

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Abstract: We have developed a preliminary learning support system for zoos where children can learn about the ecologies of animals while moving their bodies. For children, the zoo is a place of learning, where they can observe live animals carefully and learn about ecology. However, some animals are exceptionally difficult to observe carefully, and the observers may find it challenging to learn in such scenarios. Therefore, in this research, we developed a learning support system that efficiently acquires knowledge about the ecologies of animals that are difficult to observe in zoos. This system uses a sensor to measure the body movements of the learner; certain animals also tend to respond based on these movements. By doing so, live animals can be carefully observed virtually, and ecological learning is achieved via touch. In this work, we describe the results of evaluating the usefulness of the current system by developing a prototype and evaluating experiments as the first step towards realizing a learning support system to achieve ecological learning of animal observations in zoos.

1 INTRODUCTION

Every year, hundreds of millions of people worldwide visit zoos, and most of these visitors are children (Wagoner and Jensen, 2010). For children visiting these zoos, the zoo is an important place of learning outside the classroom where they can engage with live animals (Wagoner and Jensen, 2010; Allen, 2002). The primary reason why the zoo is a popular place of learning is that one can learn about animals and their ecologies in a more detailed manner by observing live animals in their own environments (Braund and Reiss, 2006; Mallapur, Waran and Sinha, 2008). Therefore, it is quite meaningful for children to observe animals in zoos. However, it is oftentimes difficult to observe live animals, which thrive in exceptional circumstances, over time, e.g., animals that are difficult to observe because they move fast or remain hidden. In such cases, children cannot carefully observe the animals or learn efficiently about their ecologies. This is a challenge that has to be solved in order to improve the quality of learning. Various studies have been conducted and reported to support such learning measures. Studies that use tablets and mobile phones are the mainstream in these research works. For instance, a penguin's movement is difficult to observe when it is moving fast; A previously reported study aimed to learn the ecology of penguins by looking at an animation of a penguin moving slowly by using a tablet (Tanaka et al., 2017). Animals that have small statures are generally difficult to detect and observe. Ohashi, Ogawa and Arisawa (2008) used mobile phones to impart knowledge on such animals. These learning systems provide opportunities to acquire knowledge even if the actual animals are difficult to observe. However, these systems have challenges as well. For electronic items such as tablets and mobile phones, the amount of work required to build such systems is less, and the learning experience for children is not very great. Far from the opportunity actually involved in animals, has not reached the original meaning of observing living animals. Therefore, a system that addresses these problems is required. A zoo that solves this problem by allowing children to visually observe live animals in a virtual environment in close proximity is

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thus required. There is a need for a learning support system that efficiently acquires ecological knowledge such as "what to eat" or "why to act a certain way" by improving learning motivation via observation and touch.

Visitors to zoos generally want to experience meaningful contact with the animals (Jerry et al., 2008). Research shows that squeezing wisdom and immersing when children are playing (Dau and Jones, 1999; Levin, 1996). When children use gestures and movements, the learning environment becomes more natural (Grandhi, Joue and Mittelberg, 2011; Nielsen et al., 2004; Villaroman, Rowe and Swan, 2011), and children are able to retain more of the knowledge being taught (Edge, Cheng and Whitney, 2013; Antle et al., 2009).

Based on these ideas, our work provides an opportunity to virtually experience contact with animals. By learning ecology while moving the body, we developed a learning support system that could enhance emotional learning and immersive feeling in the virtual environment. In this system, information regarding the movement of a person is acquired by a sensor, and the experience with the system is operated based on this information. The content is spread across multiple screens in the learner's field of vision and is usually aimed at realistic experiences with animals that are otherwise difficult to directly touch. Also, the learner can reflect oneself in such real virtual space and incorporate physical acts as contact act. While improving the immersive feeling in the virtual space and simulating actual experience, the learners are expected to learn about the ecologies of animals, thereby improving learning motivation. By experiencing this virtual learning system and observing animals, we expect to achieve a more effective learning of ecology.

In this paper, we describe the results of evaluating the usefulness of the proposed system by developing and evaluating prototypes as the first step towards realizing a learning support system that achieves ecological learning of animal observations in zoos. The evaluation experiments were conducted at the Hyogo Prefectural Oji Zoo.

2 BODY MOVEMENT BASED ANIMAL OBSERVATION SUPPORT SYSTEM

2.1 Concept of System

We aim to support the observations of animals in zoos, and we have developed a "body movement based animal observation support system" as an observation support system to improve learning motivation and its effect on better understanding animals by using body movements. Among the animals that are difficult to observe, we have created a system with the theme “Wildcat”. A wildcat is a carnivorous mammal that is associated with the following features.

- Lives in grasslands and forests
- Hunts birds by jumping to great heights
- Vigilant, has a strong heart, and interacts poorly with human beings
- Hiding behind grass

From the view of these characteristics, a wildcat lives in grasslands and forests and is an animal having excellent jumping capabilities to hunt birds. The ecological environment changes the form of jumping depending on where the birds are located during hunting. If the bird is in the same height horizontally from the wildcat, the wildcat jumps in the horizontal direction to hunt. When a bird is at a higher position from the wildcat, the wildcat jumps vertically to hunt. Fig. 1 is a concept diagram showing how the wildcat jumps while hunting birds. However, the wildcat is strong and alert and not good at interacting with people. In addition, the wildcats hide behind grass.

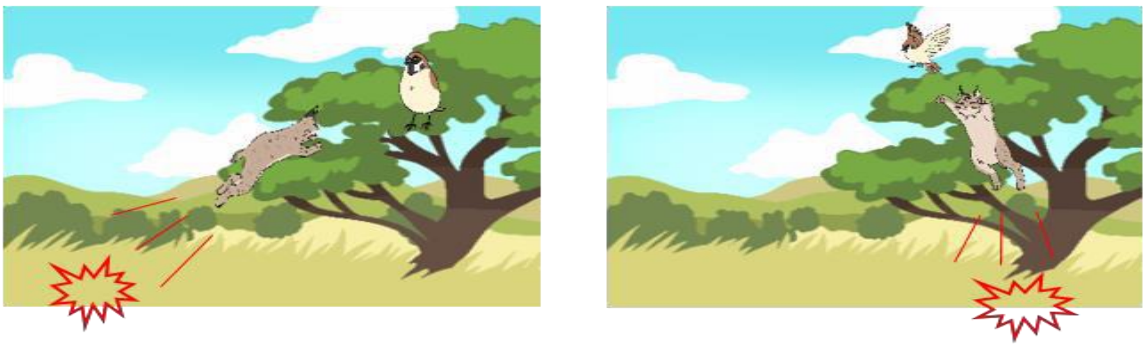

Figure 1: Example of a jumping wildcat whose purpose is to hunt a bird.

Therefore, it is difficult even in the zoo to observe this creature. It is also therefore difficult to learn about wildcat observation and ecology. We considered learning support for demonstrating the ecology with which wildcats jump to hunt birds, which is a difficult phenomenon to observe in zoos. Thus, we developed a system to observe wildcat jumps while moving the body.

2.2 Necessary Functions

The learning support system that can efficiently assist learning ecology realizes four features: immersed in the environment where the wildcat lives, move the wildcat and body, touch the wildcat, and observe the ecology of the wildcat. For the purpose of realizing these features, the following four functions are necessary:

(a) A function to project an experienced person in the virtual environment to enhance the immersive feeling.
(b) A function that allows the experiencer (user) to select the type of jump for body movement.
(c) A function wherein the wildcat moves in conjunction with user's body movement in the virtual environment for efficient interaction.
(d) A function where the user observes the ecology of a wildcat catching birds in a virtual environment for observation and learning.

By realizing (a), the user is projected onto the virtual environment in which the wildcat is located, and the user feels immersed in the virtual environment.

By realizing (b), the user can choose whether to learn about the ecology in which the wildcat is hunting birds: high places or distant places. When the user selects the type of jump, the experienced person understands that the system is about to use body movement.

By realizing (c), user can learn how to manipulate the physical movements. It is expected that the movement of the animals projected on the screen by the animals moving within the virtual environment corresponds to the body movement of the user and is perceived as realistic movements of living creatures and not as the movements of a virtual creature. Further, because the wildcat will move in the virtual environment, it is possible to touch the virtual wildcat. By realizing (d), the user can observe and learn the ecology of wildcat jumping for the purpose of hunting birds, which are otherwise difficult to observe in real life at the zoo.

2.3 Implementation

The authors used Microsoft's Kinect sensor to realize the four functions. Microsoft's Kinect sensor is a range image sensor originally developed as a home video game device. The sensor records advanced measurements with regard to the user's position. In addition, this sensor uses the software development kit library for Kinect Windows to recognize humans and human skeletons. Kinect measures the position of a human body part such as hands and feet and uses this function and position information to identify the user's pose and state.
Next is the extraction of the human region. In Kinect's human body database, various human body posture patterns are realized through machine learning. This is achieved by identifying the body parts from the database.

This system comprises Microsoft's Kinect sensor, a computer for controlling the Kinect sensor, and a projector projecting on the screen based on data from the computer. Fig. 2 shows a schematic of an actual system.

Next, the flow of this system is explained. When the experiencer stands in front of the sensor, the sensor recognizes the human skeleton and projects the figure of the experiencer in a virtual environment. Fig. 3 (1) shows this state.

Experiencers imitate images projected on the screen using body movements. The sensor recognizes the posture of the person, and the screen switches according to the type of jump selected. As the screens switch, a wildcat and birds appear on the screen. Depending on the type of jump selected, whether birds are placed upwards or birds are placed horizontally relative to the wildcat within the screen is decided. By doing so, the environment where the wildcat hunts the bird is realistically simulated. Fig. 3 (2) shows this state.

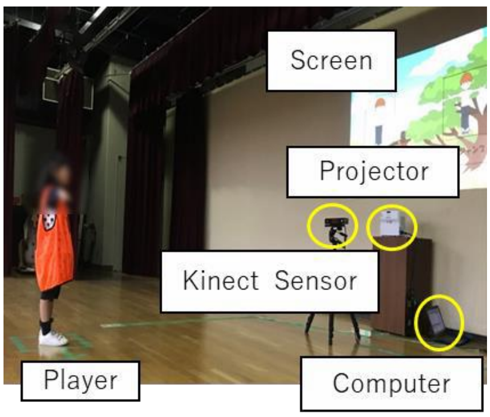

Figure 2: Outline of the actual system.

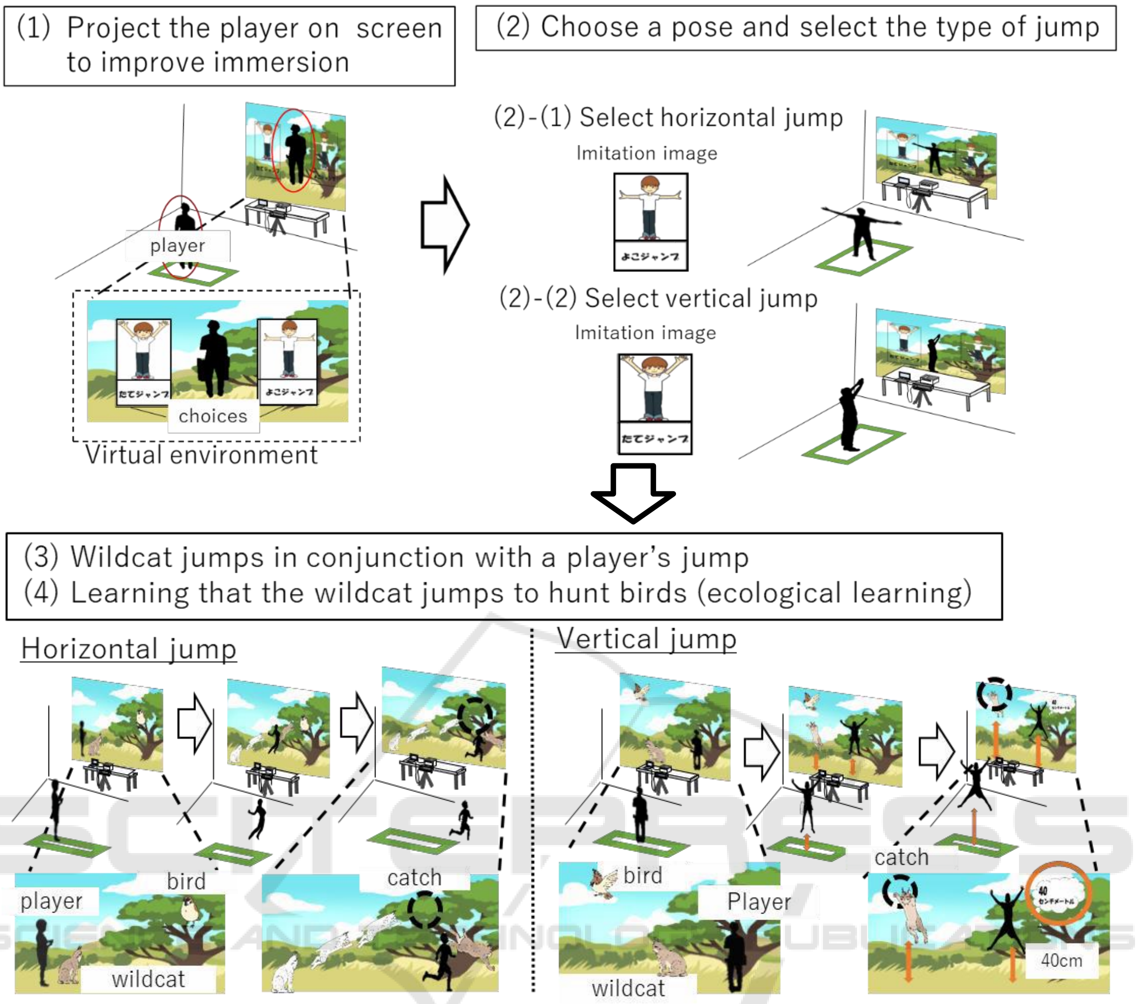

Figure 3: System flow.

When the experiencer jumps toward the bird where the experienced person is positioned, the wildcat moves according to the jump of the experiencer. The sensor obtains the position coordinates of the ankle of the experiencer and sets it as the height and width of the jump.

When the experiencer jumps over a certain height or a certain width, the wildcat on the screen hunts the bird and the birds placed on the screen disappear. The system experiencer can learn by observing a virtually living wildcat while moving their body to act as if the wildcat jumps to catch birds. When one jumps toward a vertical bird, the height of the experienced jump is displayed on the screen. Moreover, if you jump toward the horizontal birds on the screen, the trajectory of the jumping wildcat will be displayed. This state is shown in Fig. 3(3) and 3(4).

3 EVALUATION EXPERIMENT

3.1 Method

Participants: Participants are 20 first-grade elementary school students belonging to a national university corporation (12 girls and 8 boys).

Place: Hyogo Prefectural Oji Zoo. Date: October 18, 2018.

Evaluation: After individually experiencing the system created inside the zoo's hall, the experiencers evaluated the system. Evaluation items were taken from three viewpoints: immersion and attention to the created system, attention to the wildcat, and ecological learning of the wildcat. The first two items were evaluated by the questionnaire, and the third was undertaken via free explanation. These questions were adjusted according to the participants. The responses to the questionnaire were classified based on a five-point Likert scale.

3.2 Results

Among the responses obtained, we classified “Strongly Agree” and “Agree” as positive responses and “Neutral”, “Disagree”, and “Strongly Disagree” as neutral or negative answers. The significance of the bias between the numbers of response was examined by a 1 × 2 direct probability calculation. For reversal items (those denoted by “R”), analysis was performed after reversal treatment. Table 1 shows the results of the questionnaire. A significant bias of 1% level was observed for the three items: “I enjoyed the system very much”, “This system is very interesting”, and “This system was very attractive”; $p < 0.01$). In addition, the number of positive answers exceeded the number of neutral or negative answers. Meanwhile, a significant bias of 1% is seen for the two items: “The system is boring” and “I was not interested in the system.” ($p < 0.01$). Moreover, negative answers outweigh neutral or positive responses. From these results, it can be said that the created system attracted the interest of the target. Moreover, a significant bias of 1% level is recognized ($p < 0.01$) for the item “I experienced the system and got interested in real Wildcats”. From this, it can be said that the system motivated people to learn about wildcats. In addition, Table 2 shows the results of the questionnaire regarding the reason why a wildcat jumps. Fifteen out of 20 people answered, “To hunt” or “To catch prey”. From this, it can be said that it was understood that the wildcat aimed at hunting birds by jumping. This was experienced through the created system. By experiencing the system, we can conclude the following three notions.

- The system attracts the interest of people
- It motivates them to learn about wildcats.
- The experiencer understands that a wildcat jumps with the purpose of catching prey.

Fig. 4 shows the state of the experiment. From this, it is understood that the child enjoys experiencing the system.

Figure 4: Experimental Situation.

Table 1: Results of the questionnaire about the created system.

Statements	5	4	3	2	1
I enjoyed the system very much.**	18	1	0	0	1
The system is interesting.**	16	3	0	0	1
The system is boring. (-)**	3	1	2	1	13
When I was experiencing the system, I felt like I was really competing with the wildcat.**	12	4	3	0	1
When I was experiencing the system, The wildcat felt like a real thing.**	10	6	1	1	2
I was not interested in the system.	4	2	2	0	12
When I was experiencing the system, I felt like being in the grassland.**	11	4	2	1	2
When I was experiencing the system, I felt like I was in a different world than usual.**	14	3	1	1	1
The system was very attractive.**	15	3	1	0	1
I experienced the system and got interested in real wildcats.**	14	2	2	1	1
N = 20 5: Strongly Agree, 4: Agree, 3: Neutral, 2: Disagree, 1: Strongly Disagree (-): reverse item ** p < 0.01					

Table 2: Answers to the question why the wildcat jumps.

Girl.1	To hopscotch	Girl.11	To catch prey
Girl.2	To catch prey	Girl.12	To hunt
Girl.3	To catch prey	Boy.1	To escape
Girl.4	To hunt	Boy.2	To catch prey
Girl.5	Because I raised my legs high	Boy.3	To catch prey
Girl.6	Because it is dangerous Because it seems likely to be eaten	Boy.4	To hunt
Girl.7	Because it is high	Boy.5	To catch prey
Girl.8	To catch prey	Boy.6	To catch prey
Girl.9	To hunt	Boy.7	To hunt
Girl.10	To catch prey	Boy.8	To catch prey

4 CONCLUSIONS

In this paper, we proposed a learning support system to learn about the "ecology where wildcats jump and hunt birds" as the first step to realize a learning support system to support ecological learning of animal observation in zoos. By learning about ecology while moving one's body, you can gain an immersive feeling in the virtual environment where animals live and learn it. We explained the results of the evaluation experiments to determine whether experienced people were able to efficiently undergo ecological learning.

From our experiments, it was obvious that the learner's motivation to learn improved as learners improved the immersion in the virtual environment and experienced the proposed system. Furthermore, learners have been shown to be able to learn about ecology efficiently. These results have demonstrated that the proposed system effectively provides a platform for wildcat ecology observation and learning. Otherwise, it is difficult for children to observe wildcats directly at the zoo and to undergo ecological learning.

In this paper, it was impossible to support learning for all experiencers from the result of answer to the question why the wildcat jumps. For this reason, in the future, we will involve multiple projectors and develop a system that can improve upon the immersive experiences for learners.

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