COSEY: Computer Supported Enhancement of Young Children's Cooperation

Toward a Multiple-player Cooperative Full-body Interaction Game

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Abstract: We have developed a full-body interaction game that allows children to cooperate and interact with other children in small groups. The intent of the full-body interaction game developed in this study is to encourage cooperation between children. The game requires two children to jump together with the same timing. We let children experience the game, and observed the children using several strategies to coordinate the timing of their jumps. These included shouting time, watching each other, and jumping in a constant rhythm as if they were skipping rope. In this manner, we observed the children playing the game while cooperating with each other. Therefore, the game enabled children to experience cooperation with others by using body movements.

1 INTRODUCTION

The importance of play in early education is recognized by education systems around the world (Samuelsson, I. P., 2008). Studies show that as children play, they create knowledge (Dau, E., 1999, Levin, D., 1996). Children learn well by being active (Samuelsson, I. P., 2008). Kinesthetic learning facilitates cognitive development (Tscholl, M., 2013), particularly for younger children (Engelkamp, J., 1991, Goldin-Meadow, S. 2009). When children use gestures and movements, the learning environment becomes more natural (Grandhi, S. A., 2011, Nielsen M., 2004, Villaroman, N., 2011) and children are able to retain more of the knowledge being taught (Edge, D., 2013, Antle, A., 2009). Based on these research efforts, many full-body interaction games have been developed as learning support systems for children. These full-body interaction games allow children to acquire knowledge by interacting with the system though body movements.

In addition to knowledge, sociality and cooperation are important for children's growth. Sociality and cooperation are acquired from actual experiences gained when interacting with others to achieve some goal. Group size was the only factor to significantly affect cooperation, with children in small groups cooperating significantly more than children in larger groups (Anuska, 2008). Gender and subject matter had no effect on cooperation (Anuska, 2008). However, although many full-body interaction games have been developed as learning support systems for children, very few of them allow children to cooperate with others in small groups to enhance cooperation skills. Previous learning support systems for children that used full-body interaction games tended to emphasize interaction between the children and the system. There was almost no emphasis on interaction between the children.

Therefore, this study aims to develop a full-body

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interaction game that lets children interact with each other. To that end, we developed a full-body interaction game that allows children to cooperate with others in small groups. Based on findings in previous studies, the game is designed to enhance cooperation between children by allowing them to cooperate with others in small groups by using body movements. As the first step in our study, we developed a full-body interaction game that allows two children to cooperate with each other. This paper provides an overview of the current implemented game, and describes an experiment in which children were observed played the game.

2 CURRENT IMPLEMENTED GAME

2.1 Concept

The game developed in this study enables children to interact with each other. Figure 1 shows an overview of the game. A certain device, a meter, and lamps expressing the "electricity" of the device are projected onto the screen. In this game, two players are asked to cooperate to "make electricity." The device's electricity is generated through the cooperation of two players, who must jump together with the same timing. Two players cannot make electricity without adjusting their reciprocal timing.

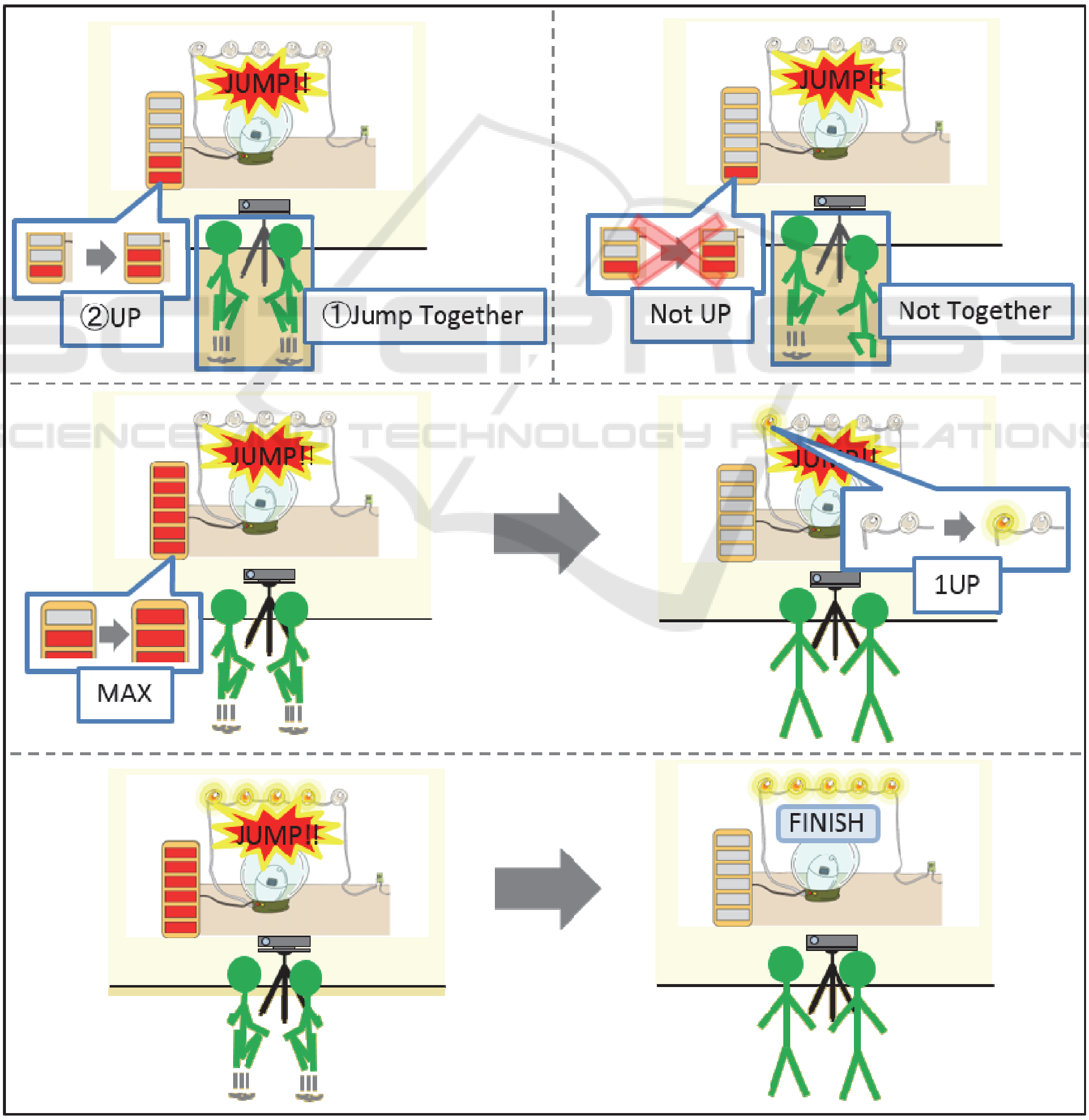

Figure 1: Overview of the game.

If two players jump together with the same timing, the red meter on the left side of the screen increases. When all lights on the red meter are lit, the lamp on the top of the screen is also lit. When all lamps are lit, electricity has been generated for the device and the game finishes. To achieve this, two players must jump together with the same timing; thus, it is likely that the two players will communicate with each other. For this reason, the game developed in this study produces interaction between children.

2.2 Overview and Configuration of System

Figure 2 shows an overview of the system. The system consists of a screen, a short focus projector, a notebook computer, and a Kinect sensor. The notebook computer operates the Kinect sensor and controls the game screen. These operations and controls were implemented using a C# program that we developed in Visual Studio 2013. The playing area recognized by the sensor is set freely by the program. The Kinect sensor is a range image sensor, originally developed as a home video game device. Although inexpensive, the sensor can capture complex measurements that accurately represent the user's location. In addition, by using a library such as KINECT for Windows SDK., this sensor can recognize humans and the human skeleton. It can measure the locations of human body parts such as hands and legs. By using these functions, the Kinect sensor can recognize the gestures of a person. Jump gestures are used to progress the game developed in this study. Figure 3 shows the configuration of the system. The notebook computer processes jump information recognized by the Kinect sensor. The game screen, which is projected by a short focus projector, changes according to the processing results. Jump recognition achieved with the Kinect sensor is discussed in the following section.

2.3 Jump Recognition by Kinect Sensor

2.3.1 Tools

Kinect Studio and Visual Gesture Builder are used to recognize and process jumps captured by the Kinect sensor.

Kinect Studio can record the 3D position information of a human body captured with a Kinect sensor. By using this tool, a player's 3D position information can be recorded when they make a gesture that must be recognized by the system. This data can be used to train the gesture reader in Visual Gesture Builder, by means of a machine learning process. The gestures the system needs to recognize are recorded by Kinect Studio in a clip file, which is used by Visual Gesture Builder as training data. In this file, frames that contain gestures that must be recognized by the system are marked. The gesture reader learns the 3D position information of players while building its gesture database after the frames are marked. In this manner, the gesture reader can learn the gestures that must be recognized in Visual Gesture Builder. A program that recognizes gestures captured by the Kinect sensor can be created by accessing the gesture reader that was trained by Visual Gesture Builder.

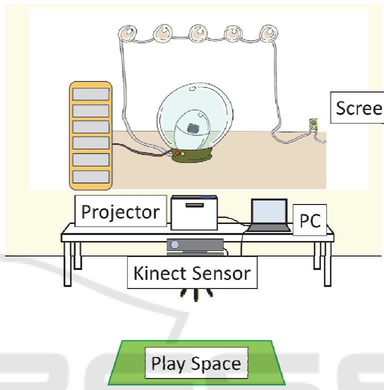

Figure 2: Overview of the system.

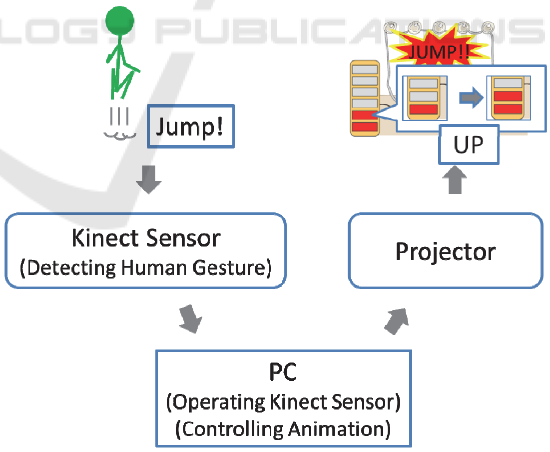

Figure 3: System configuration.

2.3.2 Recording Jumps of Children

The full-body interaction game developed in this study is for children. Because of this, the training data used for learning in Visual Gesture Builder should be collected from children, not adults. The Kinect sensor recognizes the jumps of children in the game developed in this study. Therefore, manners of jumping specific to children must be recorded by Kinect Studio. A jump reader that can recognize the jumps of children must then be built. Figure 4 shows the flowchart for building a jump reader that can recognize children's jumps. First, we recorded our own jumps in Kinect Studio and built a simplified version of a jump reader in Visual Gesture Builder. This reader cannot effectively recognize the jumps of children. Second, a simplified version of the game that can be played by one player was developed. Third, we let children play the simplified version of the game. On that occasion, the children's manners of jumping were recorded in Kinect Studio. Thus, the training data used for learning in Visual Gesture Builder were collected from children. Finally, the jump reader was

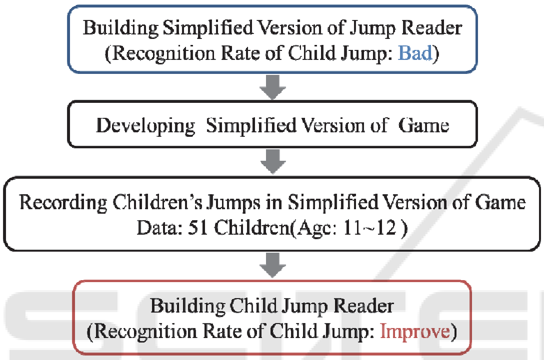

Figure 4: Flowchart for building jump reader that can recognize jumps of children.

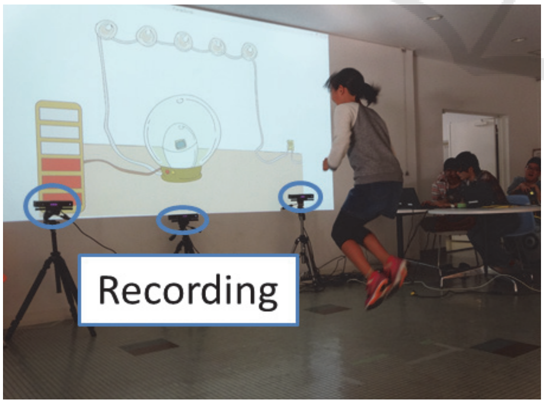

Figure 5: Children's manners of jumping are recorded.

rebuilt using the training data collected from children. As a result, the jump reader was improved to recognize the jumps of children. Figure 5 shows the children's manners of jumping being recorded. During this process, we recorded the jumping manners of 51 11- and 12-year-old children.

3 DEMONSTRATION EXPERIMENT

3.1 Study Participants and Environment

Twenty 6th-grade elementary school children played the game developed in this study. The children were arranged into 10 groups, with two players in each group. Figures 6 and 7 show the demonstration environment. The dimensions of the play space were provided within the demonstration environment. We told only one player in each pair how to play the game. The other player waited outside the demonstration room while his/her partner was told how to play the game. The other player then entered the room and was told how to play the game by his/her partner. The game started after game playing instructions were given from one partner to the other. Game play was captured by a video camera.

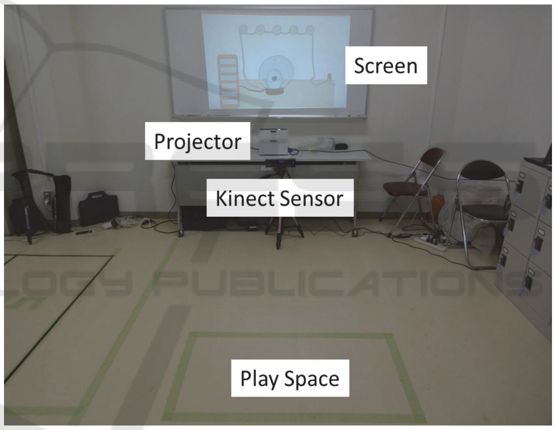

Figure 6: Demonstration environment #1.

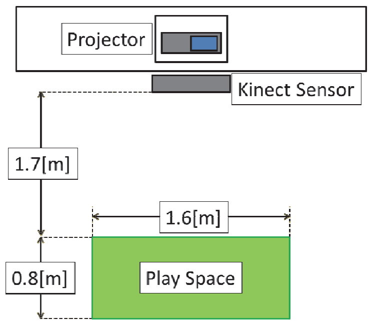

Figure 7: Demonstration environment #2.

3.2 Observing Children Playing the Game

Figures 8, 9, and 10 show the children playing the game.

Figure 8 shows the children who were told how to play the game telling their partners how to play the game. The following explains were voiced:

- "We must jump with the same timing."
- "If two players jump together, the meter increase."
- "Let's jump after saying "One, Two, Three.""

In nine out of the 10 groups, the children who were told how to play the game by their partner asked their partner to confirm the rules of the game. In these cases, we observed children assuring one another about uncertain matters.

Figure 9 shows instances in which two children were able to coordinate the timing of their jumps. Instances in which two children coordinated their jumping by watching each other were observed in all groups. Further, we observed instances in which children shouted cues to coordinate their timing. These states were often observed in groups that were previously unable to coordinate their jumps. In these cases, we observed children trying to cooperate with each other to coordinate their jumps. Further, one group jumped in a constant rhythm, as if skipping rope. This group could play the game more efficiently.

Figure 10 shows instances in which two children jumped together with the same timing. In this experiment, children thought out ways to play the game more efficiently. As these results show, we developed a full-body interaction game that allowed two children to cooperate with each other to play a game.

4 CONCLUSIONS

We have developed a full-body interaction game that allows children to cooperate with others in small groups. Based on findings in previous studies, the game was designed to enhance cooperation between children by allowing them to experience cooperation with others in small groups through body

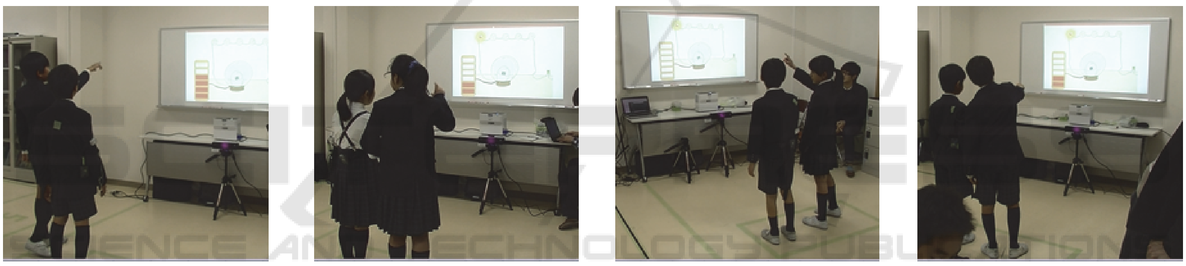

Figure 8: Children who were told how to play the game first needed to tell their partners how to play the game.

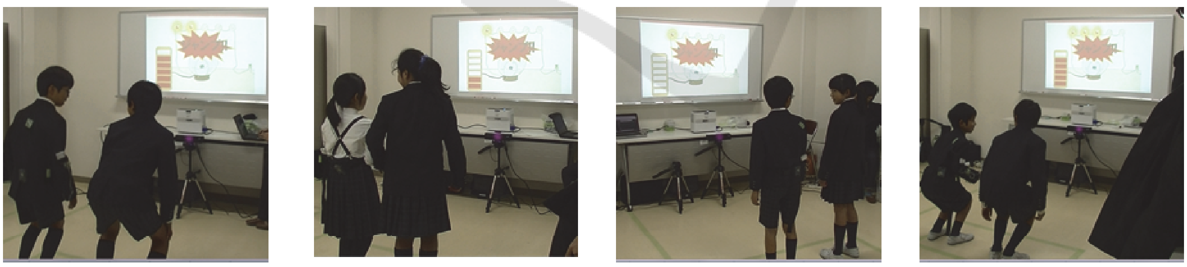

Figure 9: Children strategizing to coordinate their jump timing.

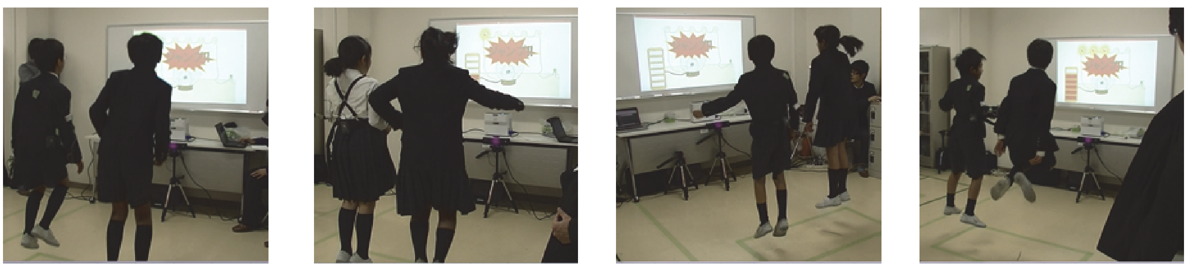

Figure 10: Two children jumping together with the same timing.

movements. This paper provided an overview of the current implemented game, and described the results of experiments in which children actually played the game. The game requires two children to jump together with the same timing to achieve a goal. We let children experience the game developed in this study. As a result, the children used several strategies to coordinate the timing of their jumps; these included shouting time, watching each other, and jumping in a constant rhythm as if they were skipping rope. Thus, we observed children cooperating with each other while playing the game developed in this study. Therefore, the game let children experience cooperation with each other through body movements. In future work, we plan to increase the number of players, in order to analyze how players might cooperate with each other in larger groups. Further, evaluation and improvement will be performed to develop a game that allows children to experience greater cooperation with others.

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