Serious Game for the Evaluation of Cognitive Function of Kids

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Abstract. This paper describes the serious game contents for the evaluation of cognitive function for kids. The game contents were designed for measuring and enhancing the cognitive function of the kids (ages 5–7). We clustered the measurable cognitive functions as auditory attention, visual attention, attention shift, and impulse control. This study is based on the advisory of the Department of Psychiatry and Behavioral Science, Seoul National University College of Medicine. In impulse control task, we applied the vision based head tracking technology. This study is meaningful on the point view that we can evaluate and enhance the cognitive function of kids who are familiar with the computer environments.

Keywords: Cognitive function · Serious game · Impulse control · Visual attention · Attention shift · Auditory attention

1 Introduction

1.1 Cognitive Evaluation

Cognitive evaluation means the ability to discerning and then recognizing the object. Maintaining the cognitive evaluation skill controls the number of factors that can degrade memory or concentration in order to maintain the functionality of normal brain [1]. When the cognitive evaluation is further refined, it includes mental abilities such as knowledge, understanding, thinking skills, problem solving skills, critical thinking, creative thinking, etc. Impulse control, auditory-verbal memory, and visual-spatial memory can be enhanced through training [2–5].

1.2 Backgrounds of Cognitive Evaluation Methods

Existing cognitive evaluation has been used a problem-solving approach, which consists of 4 or 5 multiple choices with respect to each item. This is a valid approach for children over the age of 12, who are proficient in reading the letter and determining the visual information. Cognitive evaluation methods for the low age children are card selection or modeling tools, which stimulate the interest of children.

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1.3 Significances of Serious Game for Child Cognitive Evaluation

A top priority subject to be considered for low age children is the visual-auditory material like image or sound, but not the letter. The proposed paper develops a cognitive evaluation game, which is a non-writing method and utilizes a touch gesture. It improves the usability of evaluation progress and the results.

2 Serious Game for Child Cognitive Evaluation

2.1 Operating Device

Operating device has been placed differently depending on the target age group. Since the behavior and judgment for children aged between 5∼7 primarily have high randomness, the evaluation game used the NUI motion recognition camera with touch gesture and the child facing direction through facial recognition as shown in Fig. 1.

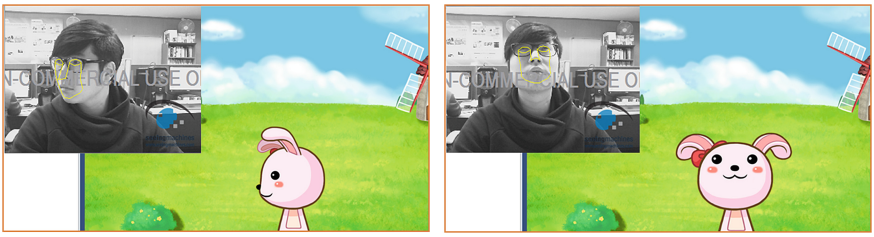

Fig. 1. Application of gesture recognition camera

The evaluation game is operated through touch interface using a touch panel display for children aged between 8∼10, who are relatively outstanding in letter analysis capability. At the same time, it is planned to take advantage of voice input through the speech recognition API in the game. However, since all of the commercial speech recognition APIs are made on the basis of adult male voice, the speech recognition is not included in the final result due to low recognition rate for children's voice.

2.2 Game Flow

Once the game starts, children enter their information. The first game screen is displayed upon completion of input, and then a total of 4 games are executed in sequential order. The general progress of game is known by performing the practice exercises preferentially and each game can proceed up to a total of 6∼7 steps. The game ends when all games are executed or when the game fails during play. At this time, the result of cognitive assessment data performed in the game is displayed. When the current game is either passed or failed, the next game gets started. The result of game is presented to children, but also saved as a csv file such that the available data can be transferred to the rating agency.

2.3 Game Concept

The proposed cognitive evaluation game is developed in two versions: one for children aged between 5 ~ 7 and the other for children aged between 8 ~ 10. The differences between two versions are the difficulty of game itself, visual preferences of children, and the differences in the concentration. The prior version is made using a primary color and a simple form of the UI as shown in Fig. 2 (Left). In contrast, greater variety of color and complex forms of the UI are used in the latter version as shown in Fig. 2 (Right).

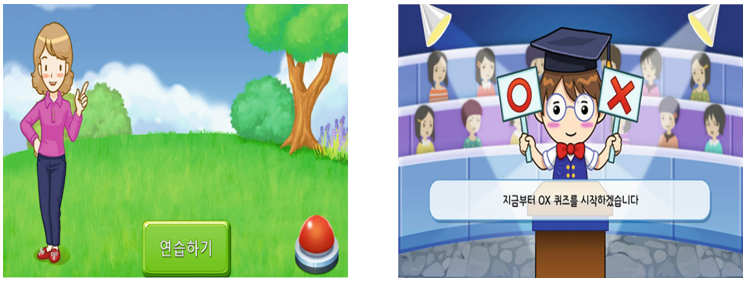

Fig. 2. Snapshot of game evaluation screen for ages 5–7 (left) and ages 8–10 (right)

A story narrative is included in each of game such that there is no discomfort of progressing the game at the location presented in background image. In addition, the concentration of children gets elevated by naturally showing the feedback according to the game progress.

2.4 Game Engine

Unity 3D engine that can take advantage of a variety of plugin (as shown in Fig. 3) is used because we have concluded that availability on a variety of devices is important to apply the proposed gesture recognition camera and touch panel display.

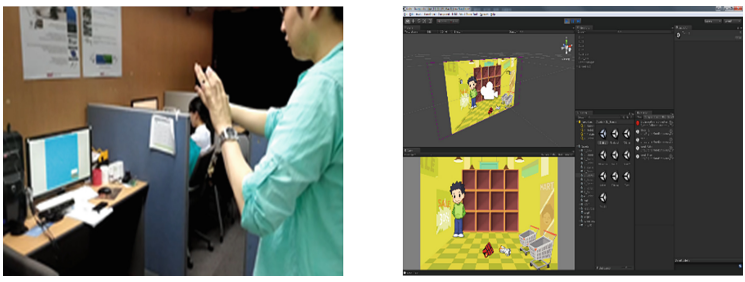

Fig. 3. Testing camera for gesture recognition and unity 3D engine

The strengths of Unity 3D engine include easy porting to another platform and linkage to a variety of gesture recognition device through the plugin package. Thus, Unity 3D engine can be effectively used.

2.5 Game Development

Unity 3D is a 3D game engine, where the proposed evaluation game should be configured in a 2D screen so that children can be easily recognized. Thus, the final visual information is needed to be configured as a 2D screen. Even though Unity supports 2D functionality, but we have determined that this is not the intention of 2D screen effect and the game contents are made using NGUI. Button and UI elements are used to configure the screen through NGUI, and then sphere collision is used for moving or manipulating object to verify the collision check as shown in Fig. 4.

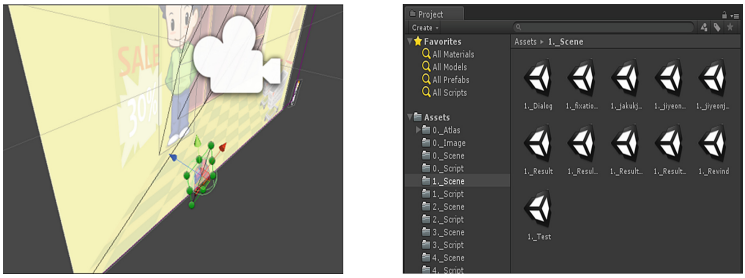

Fig. 4. Snapshot of item using sphere collision and separated scene management

Evaluation games for children aged between 5 ~ 7 and 8 ~ 10 are programmed differently, where each has GameManager class that controls the entire game flow including full screen UI and game progress.

Both manager and scene are set apart according to each type of game. When the game starts, it is moved to the scene in order to progress its game. Once it is completed, the results are passed to the manager such that the output data can be made as a csv file (as shown in Fig. 4). For the difficulty level, it has a linear relationship such that once a certain score has been recorded on the lower level, it automatically allows to play a higher level. However, when the condition is not satisfied, the game is terminated and output its results (as shown in Fig. 5).

In the game for children aged between 8 ~ 10, there is a game that must process the evaluation after a certain period of time. Thus, based on this condition, it allows to select the level directly rather than using the prior data in order to enhance the easy of evaluation environment.

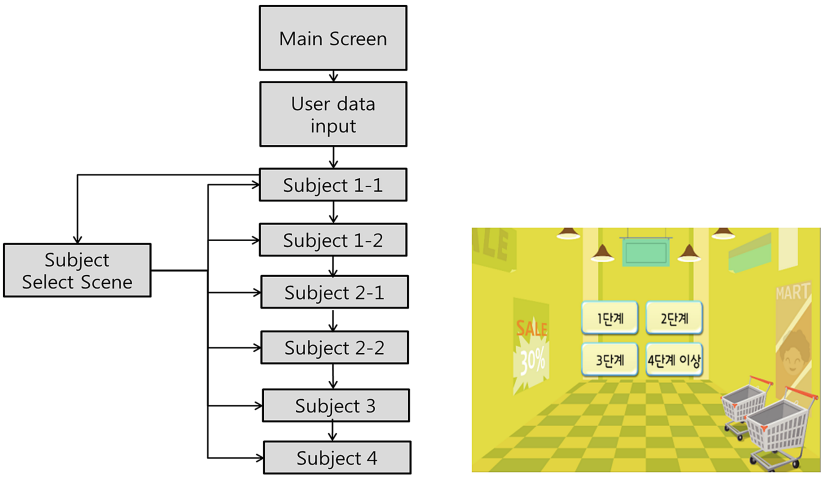

Fig. 5. Flow chart of scene progress and selecting game level

3 Conclusion

Cognitive evaluation of children in Korea is known as either the reading voucher that is run independently in a municipality or the professional domain that needs to purchase expensive evaluation/training tool separately. Flawless supply is essential in order to improve this situation, but it is not easy due to the number of expertise and unreasonable assessment method.

This paper proposed the child cognitive evaluation game to be used without restrictions of place, time, and cost. In addition, the proposed evaluation game will improve the overall children's welfare with increasing easy of expert organizations. Since the color and UI configuration, and operation methods were set differently according to the children's age, the proposed method can also be the basis for developing similar contents in future.

The proposed game is based on the children's cognitive evaluation, which evaluates the child's auditory-verbal memory and visual-spatial memory to support motivation and concentration. Developing training contents that is self-interested and improving the cognitive ability is left as a further work.

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