

Development of Gesture Recognition-Based STEAM Educational Games Focused on Korean Traditional Archery

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Abstract. The purpose of this study was to develop the gesture recognition-based STEAM educational game focused on Korean traditional archery. The game adopted the story of the Korean movie *War of the Arrows* and included educational contents based on the scientific principles of archery to help users shoot well in archery games. The game was demonstrated at the exhibition booths in the BIFF Village during the 2015 Busan International Film Festival (BIFF). Learning through body movements based on scientific knowledge could be a good approach for designing STEAM education program. The program's contents include the scientific principles of archery, such as kinetic energy, kinematics of projectile motion, and predicted aiming method. The first key issue in the development was the robustness and usability of the gesture recognition system for on-site installation. The second key issue was the customized content for immediately increasing the interests of users. The difficulty of the game was determined by the archery target size and control. The user controlled the game with his or her own gestures: Aim was controlled by the user's left hand, and the firing gesture required putting the user's right hand up. We tested the gesture recognition-based art education game with many participants at the exhibition. Participants' reaction was very favorable. Most people could play the game easily and intuitively. After the experience, users' feedback was almost entirely positive. However, kids younger than six years old and elderly people over sixty-five could not play the game as easily. These facts should be considered for an educational game design.

Keywords: Gesture recognition-based game · NUI · Korean traditional archery · STEAM education · Science · Kinect

1 Introduction

Nowadays, the use of an interactive digital game as educational media has been expanded [1]. The entertainment characteristics of digital games help improve self-active learning [2]. Many researchers have investigated the advantages of educational games on students' learning in a variety of subjects. Digital games are also a powerful

tool for the visualization of learning contents. The importance of active learning has been reported by educational professions and teachers [3]. Digital games are a useful tool for self-active learning. When users play a game, they are learning, acting, and interacting with the contents.

Archery is a good sport for mental and physical health and fitness. Consequently, many people enjoy archery games. The Korean traditional archer aims without using additional means like eyeholes and targeting tools. Achieving good shooting results requires much experience and practice. However, opportunities to experience and practice Korean traditional archery are rare. Thus, many novice players have trouble with the difficulty of learning how to aim and shoot. Therefore, game-based learning in archery aiming has benefits without costs (e.g., time, money) [4].

The purpose of this study is to develop the gesture recognition-based STEAM educational game focused on Korean traditional archery. To promote learners' interest, the game borrowed the story of the Korean movie *War of the Arrows*. In addition, it included not only fun factors, but also educational contents based on scientific principles of archery to help users achieve good results in archery games. The game was demonstrated at an exhibition booth during the 2015 Busan International Film Festival (BIFF) at the BIFF Village installed at the Haeundae beach entrance. Visitors to the BIFF Village were able to experience and learn archery through interactive games based on gestures. In the process, such an experience could also provide PR and promotion for the Korean traditional archery.

2 STEAM Education

This application could be utilized in science, technology, engineering, art, and mathematics (STEAM) education programs, which provide scientific knowledge and specific experience of learning through bodily movements. Nowadays STEAM fields have become essential because game-based education offers opportunities for students to develop their creativity and imagination [5]. Learning through bodily movements based on scientific knowledge could be a good approach for designing STEAM education programs. The contents of the program under study include scientific principles of archery (e.g., kinetic energy, kinematics of projectile motion, predicted aiming method) that make the game much more interesting and real. Users' experiences improved their understanding of the skill of archery.

3 Development of Game

3.1 System Architecture

Our system consists of a Kinect sensor, a laptop PC, and a TV kiosk. In order to develop the game and implement the logics, we utilized Zigfu, a programming development toolkit, and Unity, a cross-platform game creation system [6]. Figure 1 shows the system architecture and user interface of this system.

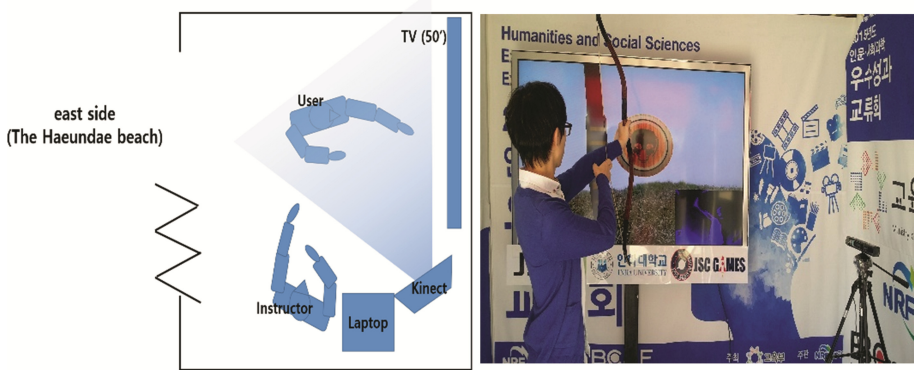


Fig. 1. System architecture and user location. The game system is configured with Kinect, a laptop PC, and a large LCD TV

3.2 Game System Setting

The issues that should be considered in the development are, first, robustness and usability of the gesture recognition system for on-site installation and, second, customized content to increase the interests of users at once because our booth was installed at the Haeundae beach entrance to the BIFF Village, where the sunlight lit up the booth each morning.

The difficulty of the game was defined by the archery target size and control (big → small, fixed → slow movement → fast movement). Archery operations applied to this game were divided into firing using the right hand and aiming using the left hand. The user moved his or left hand up, down, left, and right to aim the bow in the game. Right-hand shooting was implemented through the operation of lifting the hand over the head.

4 Exhibition Lesson and Users' Feedback

We tested the gesture recognition-based art education game with many participants at the exhibition, whose reaction was very favorable. Learning how to play the archery game was very easy. People of all ages could easily and intuitively play the game, the users' feedback was almost unanimously positive. However, kids younger than six years old and elderly people over sixty-five years old indicated some difficulty playing the game. They complained about the difficulty in understanding how to use the gesture-based control in the game. This is because the natural user interface (NUI) is not natural (Fig. 2).

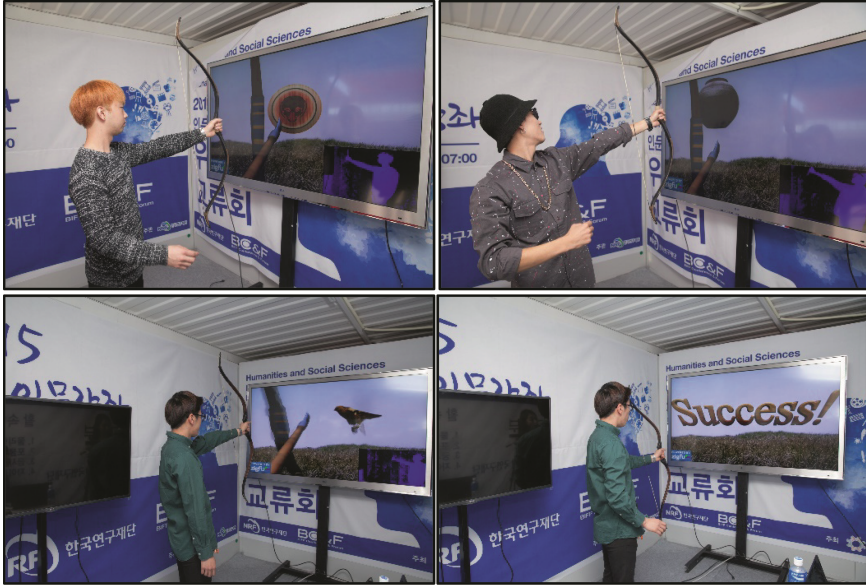


Fig. 2. Three different targets had different difficulty levels. (Upper left) The fixed circle shaped target (Upper right). The slow moving pot. (Lower left) The fast flying bird. (Lower right) The pop-up image after hitting the target.

5 Conclusion and Discussion

In this paper, we proposed a gesture recognition-based STEAM educational game focused on the Korean traditional archery. To promote learners' interest, the game borrowed the story of the Korean movie *War of the Arrows* and included not only fun factors, but also educational contents based on scientific principles of archery to help users get good results in the archery games. The game was demonstrated at an exhibition booth in the BIFF Village installed at the Haeundae beach entrance during the 2015 BIFF. Visitors to BIFF Village were able to experience and learn archery through interactive games based on gestures. In the process, Korean traditional archery could receive PR and promotion. Participants' reactions to the educational game were very favorable. Learning how to play the archery game was very easy. People of all ages could play the game easily and intuitively. After the experience, the feedback of almost every user was positive.

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References

1. Miller, N.: Games in the Classroom. *Indiana Libr.* **33**, 61–63 (2014)
2. Beetham, H., Sharpe, R.: *Rethinking Pedagogy for a Digital Age: Designing for 21st-Century Learning*. Routledge, Abingdon (2013)
3. Freeman, S., Eddy, S.L., McDonough, M., Smith, M.K., Okoroafor, N., Jordt, H., Wenderoth, M.P.: Active learning increases student performance in science, engineering, and mathematics. *Proc. Nat. Acad. Sci.* **111**, 8410–8415 (2014)
4. Miles, H.C., Pop, S.R., Watt, S.J., Lawrence, G.P., John, N.W.: A review of virtual environments for training in ball sports. *Comput. Graph.* **36**, 714–726 (2012)
5. Taylor, P.: Transformative steam education for the 21st century. In: *Proceedings of The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference)*. (Year)
6. http://en.wikipedia.org/wiki/Unity_%28game_engine%29