Integrating Motion-Capture Augmented Reality Technology as an Interactive Program for Children

Chien-Yu Lin[1(✉)], Chien-Jung Chen[2], Yu-Hung Liu[2], Hua-Chen Chai[3], Cheng-Wei Lin[1], Yu-Mei Huang[1], Ching-Wen Chen[4], and Chien-Chi Lin[5]

[1] Department of Special Education, National University of Tainan, Tainan, Taiwan
linchienyu@mail.nutn.edu.tw
[2] National Pei-Men Senior Agricultural and Industrial Vocational School, Tainan, Taiwan
[3] Tainan City Da Chen Elementary, Tainan, Taiwan
[4] Tainan Municipal Syuejia Junior High School, Tainan, Taiwan
[5] Department of Leisure and Recreation Management, Da-Yeh University, Changhua, Taiwan

Abstract. The purpose of this study is to investigate the effects of free interactive games invention program on jumping performance. This study design interactive games using motion capture technology that enable participant to interact using body motion in augmented environment. Scratch 2.0, using an augmented-reality function via webcam, creates real world and virtual reality merge at the same screen. Scratch-based motion capture system which uses physical activities as the input stimulate. This study uses a webcam integration that tracks movements and allows participants to interact physically with the project, to enhance the motivation of children in elementary. Participants are 7 children in elementary school; the independent variable was some interactive games arranged by the authors, the dependent variable was the immediate effect by the intervention program on jumping performance. The experimental location was in a classroom of elementary school. The results show the Scratch-base free support system could be allowed the participants some clues, so they could have the motivation to do physical activities by themselves. The participants have a significant achievement via free Scratch-base augmented reality instead of traditional activities.

Keywords: Physical activity · Scratch 2.0 · Augmented-reality · Webcam · Motion capture

1 Introduction

Real-time interactive game is more popular [1], thus, allowing for the use of technology for physical activities [2]. Augmented reality (AR), as an interactive technology, has increasingly attracted public interest during the last few years [3, 4]. AR technology means the merging of virtual objects with real objects, resulting in augmented reality environments [5]. The output could be display such as sound or graphics [6]. Hardware components for augmented reality are: processor, display, sensors and input devices, in this study, computing devices used tablet computers with web-camera. Various

M. Antona and C. Stephanidis (Eds.): UAHCI 2015, Part III, LNCS 9177, pp. 149–156, 2015.
DOI: 10.1007/978-3-319-20684-4_15

technologies are used in AR rendering just as optical projection systems, monitors, portable devices, in this study, we used the same tablet computers. In augmented reality environments both virtual and real world could co-exist at the same time, the augmented reality applications are applied in many different fields [7], such as in education [8], textiles [9], surgical interventions [10], games [11], home-training system, online teaching [12], and learning disabilities [13].

Interactive games such as the Microsoft Xbox, Nintendo Wii or Sony PlayStation are not only for the play function, but have also been used in physical activities [14]. But Xbox, Nintendo Wii or Sony PlayStationare business product, there are not enough resource to arrange these interactive game tools in classroom. Recently, many open source could be applied, with their share their program, the users could design customers' interface, Recently, many open source or free platform have become available, which share their ideas and technology, so users can via this support to create their specific interfaces. This study via Scratch 2.0, which is a visual programming environment designed at the MIT Media Lab [15, 16]. Scratch Web site (http://scratch.mit.edu) support a free online interactive community, with people sharing, discussing their pro-grams, It also support offline system, designers could be designing, creating, and remixing one another's projects [17]. It's a collaboratively written system for free that provides information about the Scratch programming language and its website, and it continues to support designers use their open source of information. Via the free platform, designers could build, share, and participant their projects together.

The advantage of this study is that is it used laptop, via scratch 2.0 platform, the content easy to redesign or remix, thus for children to execute their activities.

2 Materials and Methods

2.1 Participants

There were 7 participants in this study, all of the children from resource classes in elementary school. This method allows the participants from resource class or study in normal class but need resource class extra support, with different disabilities from resource class, 5 boys and 2 girls. This study designed individual physical activities for the different needs of the participants to enhance their body motion motivation; we used "jump" physical activities.

2.2 Apparatus, Material and Setting

The author and co-authors are 8 teachers from university, elementary schools, junior high school and senior high school and graduate student; they all work in the field of special education, assistive technology and industrial design. We design the interactive program via Scratch 2.0 platform, then install the offline system, when the experimental process, we used the offline system to make sure in a stable environment.

They design the interactive teaching materials. The original design was a video pop balloon game, from an original program by Christine Garrity. With the Scratch 2.0 support webcam function, she designed an augmented reality interactive game.

Through webcam, user could see himself/herself and the balloons on the screen at the same time. When the balloon show on the screen, the user could use his/her hand (or any part of their body) to touch the balloon, just as Xbox-Based around a webcam-style, it enables users to control and interact with gestures instead of game controller. In this study, all the children know when they jump up to the red line; he/she could get the real time feedback including audio and visual feedback. The concept of the study is shown in Fig. 1. In the study, we focus not only on the result, but also consider the promotion in the future, from the experience, the hardware only used laptop, the less equipment and easy setup could attract teachers and parents want to participant the relative activities.

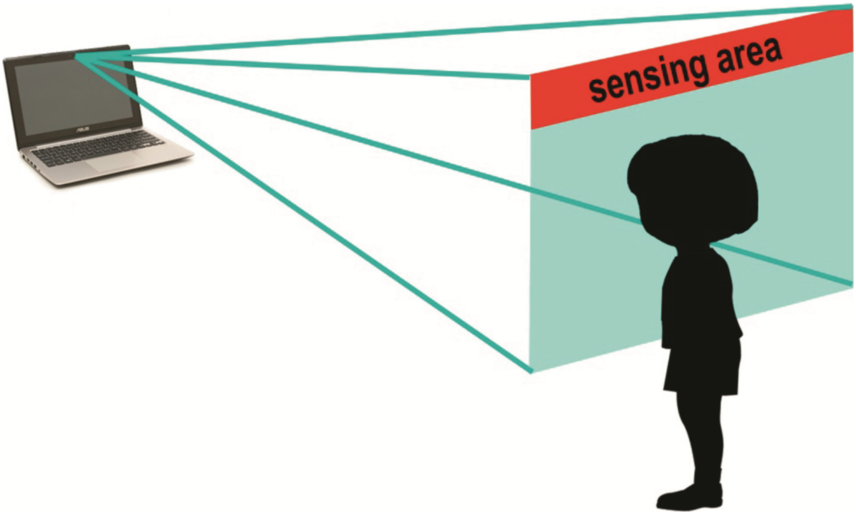

Fig. 1. The concept of this study

We used the webcam to detect the body movement on the screen. The goals for each participant were adjusted for each of their different disabilities.

2.3 General Procedure

This study focused on how the interactive audio and visual feedback can enhance the motivation of physical activities to assist children with disabilities. The laptop was arranged in front of the participants, when the participants jump up and touch the virtual red line; the participants received the visual and audio feedback dynamic pictures and sounds as feedback. Figure 2 shows the experimental setup.

The experimental process used Scratch 2.0 platform from the Media Laboratory at MIT, which allows for the development of collaborate and remix [18].

Fig. 2. The experimental process

The experimental process use laptop and internal webcam to detect jump movement and feedback effect. When the participant jumps; the webcam detects the movement when the participant jumps up into the sensor area. Because our participants were children from resource class, their response maybe not as quick as normal, and consider their ability, so the operating processing time was set to 30 s.

3 Results

3.1 Data Analysis

Because the participants were children with different disabilities from resource class, so this study focus on achievement instead of challenge, via Scratch 2.0, they have an opportunities to receive audio and visual feedback.

The record was just as from the analysis; we record the pre-test and experimental test. In the analysis, the study used t-test; this and all sub-sequent tests are two tailed.

From interactive physical activities, participants finish the jump up process. There are significant progress that used Scratch 2.0, $p = .002776 < .05$; So, Scratch 2.0 with webcam shows via augmented reality significant better than traditional physical training.

In the test trials of data analysis of physical activity, the participants have a significant achievement via free Scratch platform instead of only via traditional training.

4 Discussion

In this study, the concept via laptop and Scratch 2.0 to make a flexible free interactive game program.

The results indicated a significant result on the jump up physical activity. This study used Augmented reality (AR) could used in physical activity for children with special needs, this relative activities not only execute in elementary, we also promote the free platform in junior high school and senior high school.

Because this study applied free platform, its concept belongs to free, share, cooperate environment, teachers could be use the relative materials as reinforce. After the experimental process, we also supply related augmented reality games for them play together, just as Fig. 3. It also used the same concept and modified the original game, children tried their best to touch the balloons and enjoy get the visual and audio feedback.

Fig. 3. The modified concept for a group

While the Xbox, Wii, or Kinect may be suitable for normal people, but in resource classroom, they maybe not have the abundant resource to arrange this kind equipment, from Scratch 2.0, this problem could be getting a good resolve. In this study, we used open source and free platform to do the experiment; this is an example to promote interactive physical activity in class. We also share our experience with special education teachers in different conferences, also got positive feedback, Fig. 3 shows the process. Because the free platform interface easy to use, and the platform focus on share and rebuilt, so they can search our team and used our remix projects, so it support the interactive game design a special field for children with disabilities.

We also used the same concept, but just a little modify for young children in kindergarten and adolescents in senior high school. Fortunately, Scratch 2.0 added webcam detect motion function, that integration that can track body movements when apply on physical activities.

In kindergarten, we setup an external webcam against the wall in a kindergarten, through the projector, big pictures show on the screen and accompany with relative sounds, we took a stick pretend to hit the screen, then in the specific area, the webcam will detect body motion and give the real-time feedback - show another picture. Because they are too young and not the relative experience about AR, they are interested in touch real objects and receive feedback, via this method, they also enjoy the AR effect and Fig. 4 shows the interactive activity in kindergarten.

Fig. 4. The modified concept in kindergarten

Fig. 5. The modified concept in senior high school

In senior high school, we arrange step test to train adolescents' fitness level. The procedure of step test is step up with one foot and then the other. Step down with one foot followed by the other foot; we setup an external webcam beside the bench to detect the body movement to create an interactive feedback. So, in this case, through the laptop, the participant can receive audio and visual feedback when they do the step test, as show in Fig. 5.

Acknowledgements. This work was financially supported by the National Science Council, Taiwan, under the Grant No. 100-2410-H-024-028-MY2. Special thanks for Yu-Cheng Chen, who improve some of our programming skill.

References

1. Hwang, T.H.T.: Exploring real-time video interactivity with Scratch (Doctoral dissertation, Massachusetts Institute of Technology) (2012)
2. Kagohara, D.M., Sigafoos, J., Achmadi, D., O'Reilly, M., Lancioni, G.: Teaching children with autism spectrum disorders to check the spelling of words. Res. Autism Spectrum Disord. **6**, 304–310 (2012)
3. Olsson, T., Kärkkäinen, T., Lagerstam, E., Ventä-Olkkonen, L.: User evaluation of mobile augmented reality scenarios. J. Ambient Intell. Smart Environ. **4**(1), 29–47 (2012)
4. Radu, I., MacIntyre, B.: Augmented-reality scratch: a children's authoring environment for augmented-reality experiences. In: 8th International Conference on Interaction Design and Children, pp. 210–213. ACM Press, New York (2009)
5. Lin, C.Y., Chang, Y.M.: Increase in physical activities in kindergarten children with cerebral palsy by employing MaKey–MaKey-based task systems. Res. Dev. Disabil. **35**(9), 1963–1969 (2014)
6. Chang, Y.J., Kang, Y.S., Huang, P.C.: An augmented reality (AR)-based vocational task prompting system for people with cognitive impairments. Res. Dev. Disabil. **34**(10), 3049–3056 (2013)
7. Solari, F., Chessa, M., Garibotti, M., Sabatini, S.P.: Natural perception in dynamic stereoscopic augmented reality environments. Displays **34**(2), 142–152 (2013)
8. Wojciechowski, R., Cellary, W.: Evaluation of learners attitude toward learning in ARIES augmented reality environments. Comput. Educ. **68**, 570–585 (2013)
9. Harris, J.: Digital skin: how developments in digital imaging techniques and culture are informing the design of futuristic surface and fabrication concepts. Text. J. Cloth Cult. **11**(3), 242–261 (2013)
10. Volonté, F., Pugin, F., Bucher, P., Sugimoto, M., Ratib, O., Morel, P.: Augmented reality and image overlay navigation with OsiriX in laparoscopic and robotic surgery: not only a matter of fashion. J. Hepato-Biliary-Pancreat. Sci. **18**(4), 506–509 (2011)
11. Piekarski, W., Thomas, B.: ARQuake: the outdoor augmented reality gaming system. Commun. ACM **45**(1), 36–38 (2002)
12. Andujar, J.M., Mejías, A., Marquez, M.A.: Augmented reality for the improvement of remote laboratories: an augmented re-mote laboratory. IEEE Trans. Educ. **54**(3), 492–500 (2011)
13. Chang, Y.J., Kang, Y.S., Huang, P.C.: An augmented reality (AR)-based vocational task prompting system for people with cognitive impairments. Res. Dev. Disabil. **34**(10), 3049–3056 (2013)
14. Ding, Q., Stevenson, I.H., Wang, N., Li, W., Sun, Y., Wang, Q., Kording, K., Wei, K.: Motion games improve balance control in stroke survivors: a preliminary study based on the principle of constraint-induced movement therapy. Displays **34**, 125–131 (2013)

15. Resnick, M.: Mother's Day, warrior cats, and digital fluency: stories from the scratch online community. In: Proceedings of the Constructionism 2012 Conference: Theory, Practice and Impact, pp. 52–58 (2012)
16. Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., Kafai, Y.: Scratch: programming for all. Commun. ACM **52**(11), 60–67 (2009)
17. Resnick, M., Rosenbaum, E.: Designing for Tinkerability. In: Solari, F., Chessa, M., Garibotti, M., Sabatini, S.P.(eds.) Natural Perception in Dynamic Stereoscopic Augmented Reality Environments. (2012) Displays, **34**(2), 142-152 (2013)
18. Brennan, K., Resnick, M.: Stories from the scratch community: connecting with ideas, interests, and people. In: 44th ACM Technical Symposium on Computer Science Education, pp. 463–464. ACM Press, New York (2013)