Game-Based Motion Sensing Game Training Systems to Improve Visual-Motor Integration for Children with Developmental Delay in Special Education

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Abstract
Children with dysfunctional visual perception often exhibit limited participation in school activities, poor academic performance, and lack of independence in daily life activities. Negative experiences and poor school performance may then further delay social and emotional development. Thus, effective therapies for enhancing visual perceptual function are essential for facilitating integration in school life and for reducing the immediate and future social burden of this population. Nevertheless, treatments for children with developmental disabilities often focus on motor function rather than visual perception. Another problem is that conventional programs for improving visual perception are often limited in scope and flexibility. Therefore, this study developed and evaluated a game-based motion sensing system for improving visual-motor integration in special education children with developmental delay. The system incorporates Microsoft Kinect to provide a range of games with widely varying difficulty levels and to record the progress of the user. Special education teachers can use the system to evaluate the effectiveness of programs for improving visual-motor integration in special education children with developmental delay.

Keywords: Special education, visual-motor integration, game-based training, motion sensing game.

Introduction

Dysfunctional visual perception and visual-motor integration are often undiagnosed in early stages and can lead to difficulty performing daily life activities. Visual perception dysfunction is associated with children because visual-motor skills develop throughout childhood. Visual-motor integration is the ability to coordinate visual perceptual skills with gross-motor skills and the ability to perform movements requiring high dexterity. Visual-motor integration can also be defined as the ability to integrate visual input with motor output. A visual-motor dysfunction results from the inability of the brain to record or process visual information correctly. As a result, muscles cannot respond properly during activities that require hand-eye coordination. Visual feedback is essential for development of motor skills, which are continuously refined from childhood until adulthood. Children can improve their visual perceptual skills by playing games to practice performing everyday tasks. To improve handwriting ability, for example, a therapist may use a game requiring the user to catch a ball. Compared to children with developmental delay, children with normal development of visual-motor skills not only perform better on tasks requiring hand-eye coordination such as painting and handwriting, they often have better academic performance (Goldstein and Britt, 1994; Case-Smith, 2000).

Recent studies indicate that virtual reality (VR) learning tools may be more effective than conventional learning methods because they are easily tailored to the needs of the learner. For example, a VR environment can be designed to be simpler than the actual environment to focus on a specific task or skill and to attract the attention of the learner. Virtual reality can also enhance the enthusiasm and willingness of children to undergo physiotherapy, especially young children who are easily distracted (Jelsma et al., 2013; Winkels et al., 2013). Although VR learning environments are clearly effective in terms of providing stimuli for learners, studies have reported widely varying effectiveness for learning and many notable limitations (Rahman, 2010; Luna-Oliva et al., 2012; Di Bitonto et al., 2014). For example, most studies have focused on the use of VR for evaluation or physical therapy of children with specific conditions such as autism, cerebral palsy (CP) or spinal cord injury (SCI). Recent studies show that devices such as the Microsoft Kinect Sensor can be used for upper-limb rehabilitation in CP. Specifically, the therapist can use the system to gauge angles of movement and accuracy of movement (Goncalves et al., 2014). Another study reported that VR-based therapy is more effective than conventional therapy for improving hand-eye coordination in SCI patients and stroke patients (Roy et al., 2013). One example of a therapeutic application of the Microsoft Kinect is in rehabilitating balance and coordination in injured athletes (Vernadakis et al., 2014).

The aim of this study was to develop a game-based system for improving visual-motor skills in special education children with delayed visual-motor development.

Conclusion

Whereas conventional physical therapy is designed to improve specific dysfunctions in movement or to improve capability to perform specific daily life tasks, the game-based system proposed in this study uses motion capture to provide individualized full-body therapy for widely varying disorders. By providing continuous feedback on

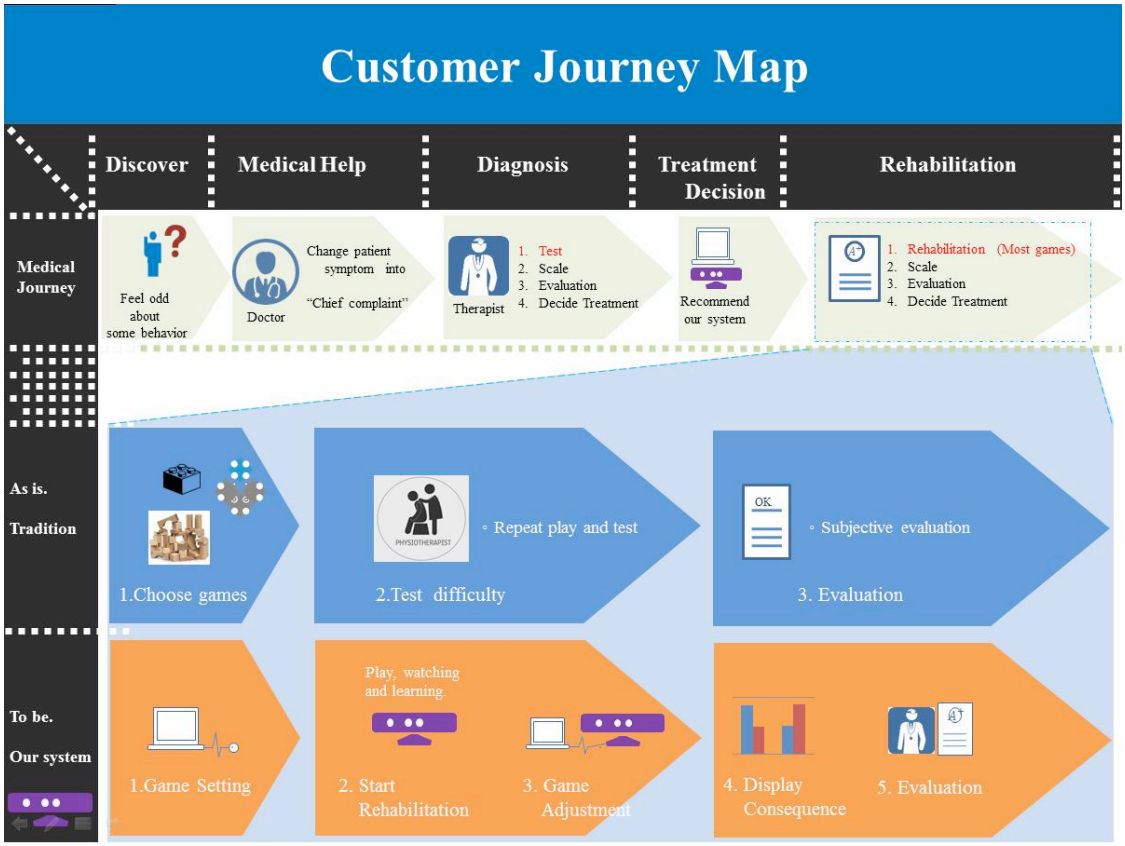

Figure 1. Flowchart of procedure for using game-based system for improving developmental delay in special education children.

improvements in capability to function in real-world environments, the system reduces the quality of life impact of visual perception dysfunction and improves the effectiveness of therapeutic treatment.

Figure 1 is a map of the procedure for using the proposed system. After children are evaluated and diagnosed in an appropriate facility (e.g., a hospital), medical personnel can design suitable physiotherapy program. Additionally, the system automatically updates and records details of the conditions and progress of therapy so that medical personnel can quickly and comprehensively review the current status of the patient. Finally, users can easily modify the data types tracked by the system.

Microsoft Kinect Sensor is an add-on peripheral for the Xbox 360 game console or for Windows OS PCs. The device includes an RGB camera and a depth sensor for full-body motion capture. The system provides interesting and realistic game-based physiotherapy by enabling users to control and interact with the content without an input device such as a controller. Figure 2 shows a screenshot of a game in which the user is required to hit an object approaching from different directions. The game was designed to evaluate coordination, reflexes, and recovery level. The efficacy of the proposed game-based non-immersive virtual reality physiotherapy system implemented in the Microsoft Kinect console system was evaluated in 60 children with developmental disorder and dysfunctional visual-motor integration. The subjects were randomly divided into a treatment group of 30 children and a control group of 30 children. The treatment group received training with the proposed system, and the control group received the standard physiotherapy regimen. After 8 weeks, data collection and statistical tests were performed to compare improvements in visual perception and visual-motor integration.

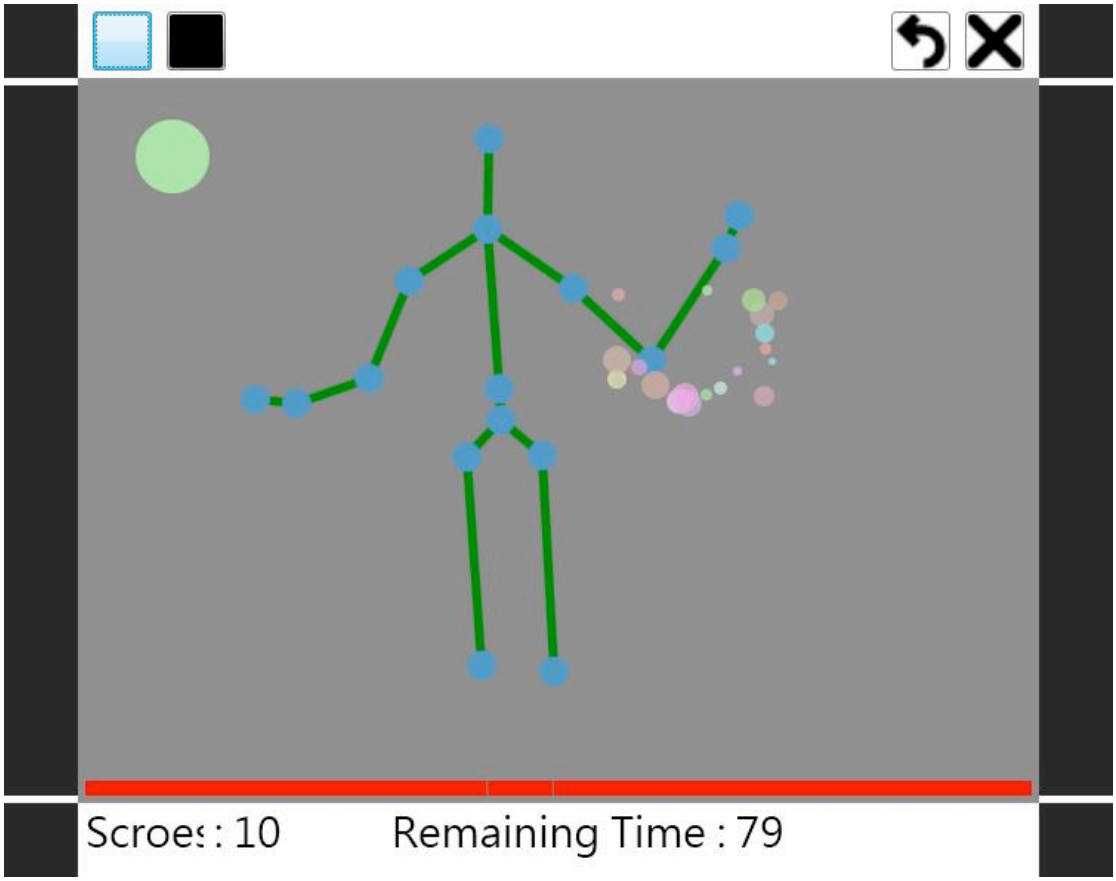

Figure 2. Screenshot of training in progress.

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