A Detecting Sensor as Interface for Children with Severe Physical Disabilities

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Abstract. Children with cerebral palsy and physical disabilities could not control the standard device, thus the purpose of this study was to redesign the interactive effect for children with physical disabilities. This study extended Makey Makey and scratch software to evaluate the possibility of operate interactive game with a high resistance switching system, whether two children (one is cerebral palsy ,the other is severely physical disabilities) would be able to participant actively by using open source software. This study was following single-subject research using ABAB designs in which A indicated the baseline and B indicated intervention. The data showed that two children with different physical disabilities significantly increased their scores on normal game. From the study, they could execute better performance during the intervention phases.

Keywords: physical disabilities, cerebral palsy, conductive substance, interface, intuition.

1   Introduction

In recent years, with technological advances, there has been using technology for special need [1],but, one of the challenges in human–computer interaction is to design systems that are not only usable but also appealing to users [2], through assistive technology for people with disabilities，those studies are very encouraging the possibility of students with multiple disabilities to request and choose among environmental stimulation with the help of microswitch and computer technology [3]. In order to run such systems effectively, efficiently and safely, much research has been developed taking into account human performance, technological possibilities [4], a computer task-based screening test could be useful for this purpose.

The adapted keyboards may have different shapes and sizes or may include keyguard covers (i.e., to facilitate the motor responses required for the writing activity and guide such responses to target one letter at a time). In spite of their facilitative features, the overall effectiveness of these keyboards may be negligible and/or their use may be very tiring for participants who present particularly serious motor disabilities [5], although many multi-screen has change the method of operate the interface, only use finger or body move to sent to information to computer and control it, special participation in more leisure activities has been shown to improve participants' physical fitness and adjustment to a life with disabilities, the majority available for

people with severe physical limitations is often extremely with different barriers ,so it is not useful for people with severe physical disabilities.

People with physical disabilities experience limitations in fine motor control, strength, and range of motion. These deficits can dramatically limit their ability to perform daily tasks independently, such as dressing, hair combing, and bathing. In addition, these deficits can reduce participation in community and leisure activities [6]. Participation in leisure activities is a fundamental human right and an important factor of life quality. Many people with intellectual disabilities also have physical difficulties which prevent them from using standard computer control devices. Custom made alternative devices for those with special needs expensive and the low unit turnover makes the prospect unattractive to potential manufacturers [7].

Just as the art games on console systems such as Microsoft Xbox, Nintendo Wii or Sony PlayStation see a recent review. It's not only for fun ,but also applied in rehabilitation treatment, depend on the therapeutic systems could leverage the games available [8]. Recently, efforts have been made to assess new sensors (A conductive substance). MaKey MaKey is an invention kit. MaKey MaKey is a printed circuit board running by Arduino Leonardo firmware [9]. It uses the human interface device (HID) protocol to communicate with the computer, and it can send keypresses. The use of Makey Makey board create a novel game controller to control different types of Flash or scratch games.

With the progress of technology, the input interface from relied on the mouse and keyboard gradually transfer to touch screen. Although the special character of touch screen is focus on learned and operated more easily by the user [10], but it could not be suit for people with physical disabilities. The MaKey MaKey uses high resistance switching to detect when you've made a connection, even though materials aren't very conductive. This study used aids on children with disabilities, compare with the expert device, the advantage is this kit could be redesign the relative conductive substance for children with physical disabilities to extent their activities.

2   Material and Methods

2.1   Participants

Participant A is an 8th grader, 14 years old, female. Her disabled condition is severely physical disabilities along with severely mental disabilities, belongs to severely multiple disabilities, type of cerebral palsy convulsions. Because of cerebral palsy convulsions, she only has operated ability on his left hand. Her right hand and both legs cannot operate mouse and bottom because of convulsions cause by tension. When she sits on kinder chair, if you don't tie on her H-suspenders, her body will suddenly tilt forward. Her upper arm and forearm have moving ability; all of her joints can move normally, and the balance of her body cannot be remaining for a long time.

Participant B is an 6th grader, 12 years old, male. His disabled condition is severely physical disabilities along with moderately mental disabilities. All of his limbs are involuntarily twitch so he needs to sits on customization Kinder chair. He cannot operate mouse and keyboard with his hands and feet. He can only control his head to move in the whole body, thus he can't join ordinary activity.

2.2   Material and Setting

The computer presented the interactive effect and recorded data. The game was de-sign by scratch software. The input device used in this study is aluminum foil . The goal for participants was to acquire the touch of any part of aluminum foil. Participant A could control the standard keyboard, but because her high tension, the standard is not a good input tool for her. Participant B could not control the standard keyboard, he can only move a part of his hand, others could not be moved, so this study design two aluminum foil blocks stick on both his ears' side of   his wheelchair seat back.

The computer was put on the table, and the participant sat in a chair(or wheel-chair), facing the computer screen.

2.3   General Procedure

This study focuses on discussing the effect of adjusted keyboard and interactive com-puter game training on operate computer in helping people with physical disabilities.

In the design of interactive effect, this study used Scratch as the software. From Scratch software, designer can create their own interactive stories, games, and anima-tions [11]. This study was focus on how to use touch conductive substance to operate whether there are response , at the beginning ,there is a black dot on the screen, the original design is when the black dot on the right, press the right arrow of the key-board, the black dot received signal and moved to the left of the screen, the operator also got score as feedback , because the participants are people with physical disabili-ties and they response slower than normal people relatively, so the operate process time is set to 1 minute.

The input device is standard keyboard. Fig. 1.illustrates the computer screens. The research adopted scratch software technology [12]. To control the experiment, this study decrease the variables. The screen was white background and a black dot. When the participant press   the right arrow key 1 time, the black will move to the right side(Fig. 1 left), then press the left arrow key 1 time, the black will move to the left side right(Fig. 1 right).
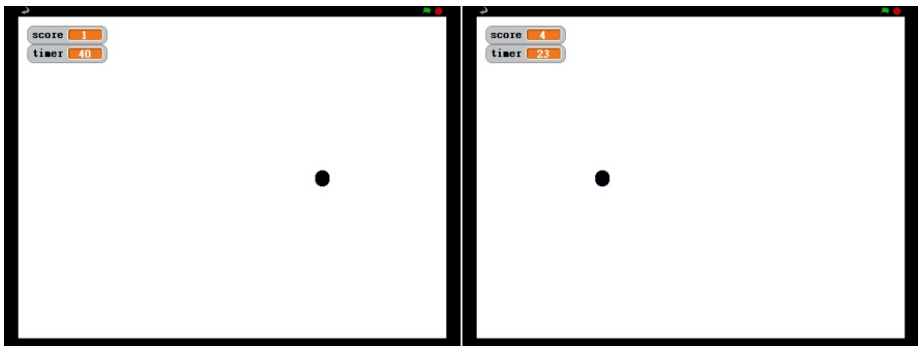

Fig. 1. Scratch interface and experiment design

The experimental design adopted ABAB reversal design for single-subject research, in which A (baseline phase) was followed by B (intervention phase), a return to baseline phase, and then a final intervention phase. The presented intervention phases while the via Makey Makey system.

The decision to limit the baseline was based on previous observation suggesting that the participants were not able to or difficult to press the button of standard keyboard. In intervention phase, The input device is adjusted aluminum foil and use Makey Makey as a connect tool between aluminum foil and computer. In this phase, worth 3 or more points, the interactive technology is introduced. Intervention I, to collect at least three points or more, and make sure the data of participant's touch the aluminum foil to maintain at least three points. A total of 6 points was achievable in this phase.

3   Results

The results from this study are based primarily on descriptive and qualitative analyses of data processing, and also participant interviews to ascertain differences between the use of interactive technological games with standard keyboard or adjustment substance. The data collected from the 4 phases were used to create a graph, where the x-axis indicates the 4 different phases and points scored while the y-axis represents the times that the participant press the correct press so get the feedback.

3.1   Participant A

Participant A, taking and operating items from left hand side is difficult. The area which is much easier for her hand to work is 20cm in front of his chest, which is about 25cmX25cm. When she operates her fingers, her thumb, ring finger and little finger will shrink back involuntarily. As the function of her hand, when she operates the keyboard, her basic ability to grab and hold is poor. Though she can still grab items which sizes are like beads, the accuracy is poor, which needs to try many times to do this. As her cognitive ability, when the questions are easy, she can express her feeling. She can also understand basic oral and gesture instructions, just as Fig. 2.
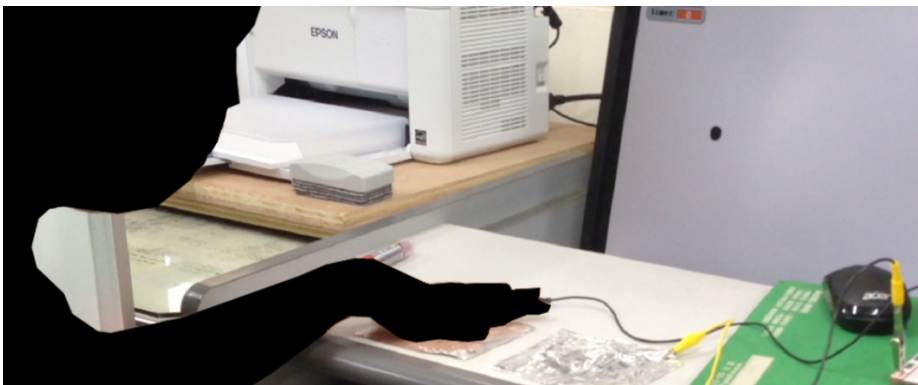

Fig. 2. intervention phases via Makey Makey system for participant A

Fig.3.shows A's data. In baseline I, The correct press scores' range is 4-11 in a minute; the average at baseline I scores was 8.
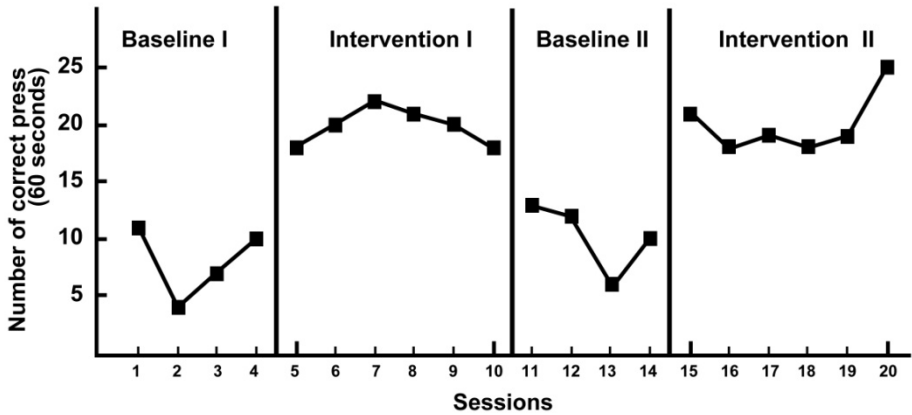

Fig. 3. A's data

3.2   Participant B

Our study adjust the original Kinder chair, installing aluminum foil at both sides of the part of B's head of the Kinder chair, and make sure that there are some space be-tween the aluminum foil and both his ears' side. When head is at the middle, it will not be connected into any aluminum foil and lead to electric conduction. When the experiment start, B looks at the screen first, and tilt his face to the right hand side, let his face touch the aluminum foil, this is the same as operate the right arrow key , get the point. And then tilt his face to the left hand side, let his face touch the aluminum foil, this is the same as operate the left arrow key, just as Fig. 4.
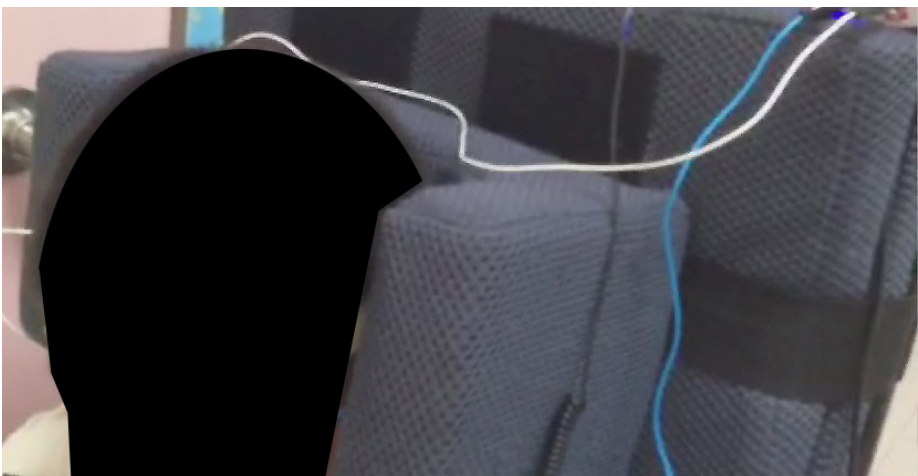

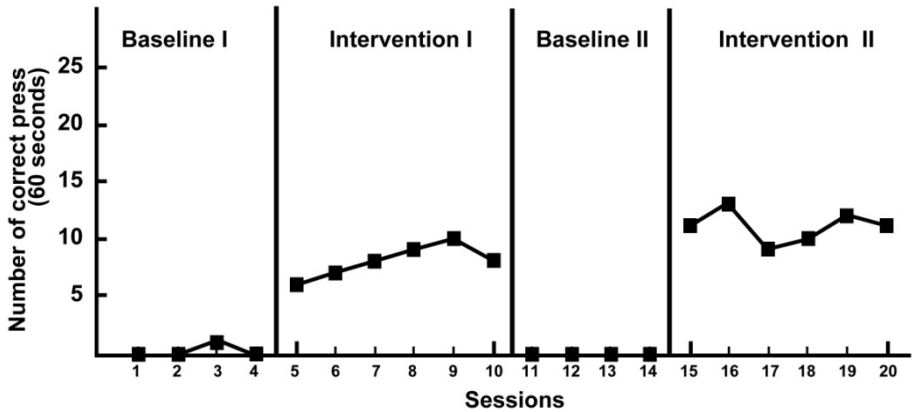**Fig. 4.** intervention phases via Makey Makey system for participant B

Fig. 5. B's data

Before the experiment, we told B to touch the right and left arrow key can have a interaction with the items in the screen, and show it to him for one time. When the experiment starts, put keyboard in front of him, at the site his hands can touch. At the process of the baseline experiment, he can't move his hands to the right and left arrow key on the keyboard, so most of that didn't get point. The point he get is because his hands touch the whole keyboard and accidently touch the right arrow key.

At the process of the intervention experiment, from the experience intervention I, he found if he let his head in a higher position, his cheek could be touch the aluminum foil easier, just as Fig.5.

4   Discussion

In this study, the use of technology from Makey Makey to make a custom-design interactive basic program was investigated for an individual diagnosed with physical disabilities. The use of Makey Makey interactive technology is to provide a variety of input substance, such as fruits, water, hairs and other electrically conductive substance in helping overcome barriers from physical disabilities, extending the different effect on different game and rehabilitation treatment.

After this study, the researchers design an activity in a daycare center for people with mind or physical disabilities, it only revise the input signal components to fit users' needs and made it be adjusted in accordance with the user's obstacles. Partial patients with paralysis but clear consciousness , muscle and nerve damage, limb hypoplasia, spinal cord injury, the elderly, and gradually freeze people have limb movement disorder, these patients still could move on some parts of their limb, the application of the results of this study could be develop interactive hardware interface design for the part of the limb that still active. Just use the same concept to redesign the device, let the limb   move and touch the conductive substance instead of pressing single switch process that bring activities for people with physical disabilities.

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