Developing an Accessibility Assessment System for Mobile Devices

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Abstract. Through the rapid evolution of the technology, more and more mobile devices have been used in a learning environment. The intuitional operational layout and less physical efforts in operating touchscreen, most people find it is easier for use compared to traditional input devices, such as keyboards and mice. However, persons with physical disabilities may encounter difficulties in accessing or operating those mobile devices due to poor control of movements and dexterities. The purpose of this study is to develop an application to help the research team to build, test, maintain, update, and scale the accessibility assessments of mobile phones. The Accessibility Assessment System was designed as a cloud-based application, and its design is task-oriented, including tapping, sliding and dragging. The time of completion of all tasks, error rate of manipulations, correctness of usage and the size of the finger press area were recorded. In addition, the results of the assessments would be automatically uploaded to the cloud database for further analysis. Through the three functional evaluation tasks of the Accessibility Assessment System, we would be able to understand the proper icon sizes, and the controllable area of touch screen on their mobile devices for the individuals with physical disabilities. For further studies, we will test AAS within different diagnoses of persons with physical disabilities, including cerebral palsy, spinal cord injury, and muscular dystrophy to look at their operational performance on the mobile devices.

Keywords: Accessibility assessment · Mobile devices · Persons with physical disabilities

1 Introduction

According to a survey of e-Market, the population of mobile phone users in Taiwan is about 73.4% [1]. With the popularity of mobile devices, it has become a necessity of

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daily life; more and more people use it for education. The intuitive operating mode of iPod or iPad can provide a more effective and efficient teaching and learning method compared to the tradition ones [2]. Although there are more and more studies using mobile devices to teach, it still needs more discussion about whether it is suitable for persons with disabilities.

According to a survey by Rehabilitation Engineering Research Center for Wireless Technologies from 2012 to 2013, it was found that approximately 40% of people with physical disabilities only have a simple mobile phone instead of a touch-screen smart phone. This reason may be that traditional mobile phones have large buttons, which are easier for persons with physical disabilities to access. However, smart phones with a touch-screen layout usually require more dexterous finger movements to operate, thus this may cause distress for persons with physical disabilities [3]. Duff et al. (2010) also found that persons with physical disabilities have a higher error rate when entering numbers on the on-screen keyboard than those without disabilities [4]. Another study also demonstrated that persons with physical disabilities have higher error rates, slower speeds and longer dwell times when operating the touch screens than people without disabilities [5]. From the literature, we can see that people with physical disabilities have many difficulties using smartphones, but smartphones are mainstream products and have their advantages in use.

Newton and Dell (2011) had mentioned that there were two major obstacles for the use of assistive devices for persons with disabilities; they were high costs and high abandonment rates [6]. Since the mobile devices are mainstream products, their prices are much cheaper than that of customized assistive devices, therefore, persons with disabilities might accept a mobile device as its low cost and as a mainstream trend. Therapists servicing persons with physical disabilities would like to provide accessibilities suggestions for them to use mobile phones barrier-free. The purpose of this study was to develop an application for mobile devices, which can simulate the functional tasks when operating the mobile devices' touch-screen layout. The APP developed by this study can assist the therapist to evaluate the difficulties of using mobile devices for persons with physical disabilities.

2 Method

The Accessibility Assessment System (AAS) was designed as a cloud-based application accessed through the web to help the research team to build, test, maintain, update, and scale the accessibility assessments of mobile phones much more quickly and less expensively. The web server architecture combined the Apache web server with PHP, Perl, and Maria DB, allowing users to easily connect the web server with their mobile phones. The design of AAS is task-oriented, including tapping, sliding and dragging. The time of completion of all tasks, error rate of manipulations, correctness of usage and the size of the finger press area were recorded. The AAS used the game style scenario to induce the subject's motivation, and the task orientation design to collect the related times and tracks of tapping, sliding or dragging through user's operation on the multi-touch screen. In addition, the results of the assessments would be automatically uploaded to the cloud database for further analysis.

3 Results

The AAS consisted of three functional tasks, which were tapping, sliding and dragging.

3.1 Tap Assessment

"Tap" means to point and select the icon on the touch screen of the mobile phone. In the assessment of tap, the sizes of icons and the areas the person is able to access were assessed through the continuous tapping tasks. Four different modules (5 * 4, 4 * 3, 3 * 2, and 2 * 1, Fig. 1a–d) were designed according to the different sizes of the icons. For example, the module 5 * 4 means that the layout of the icons on the touch screen

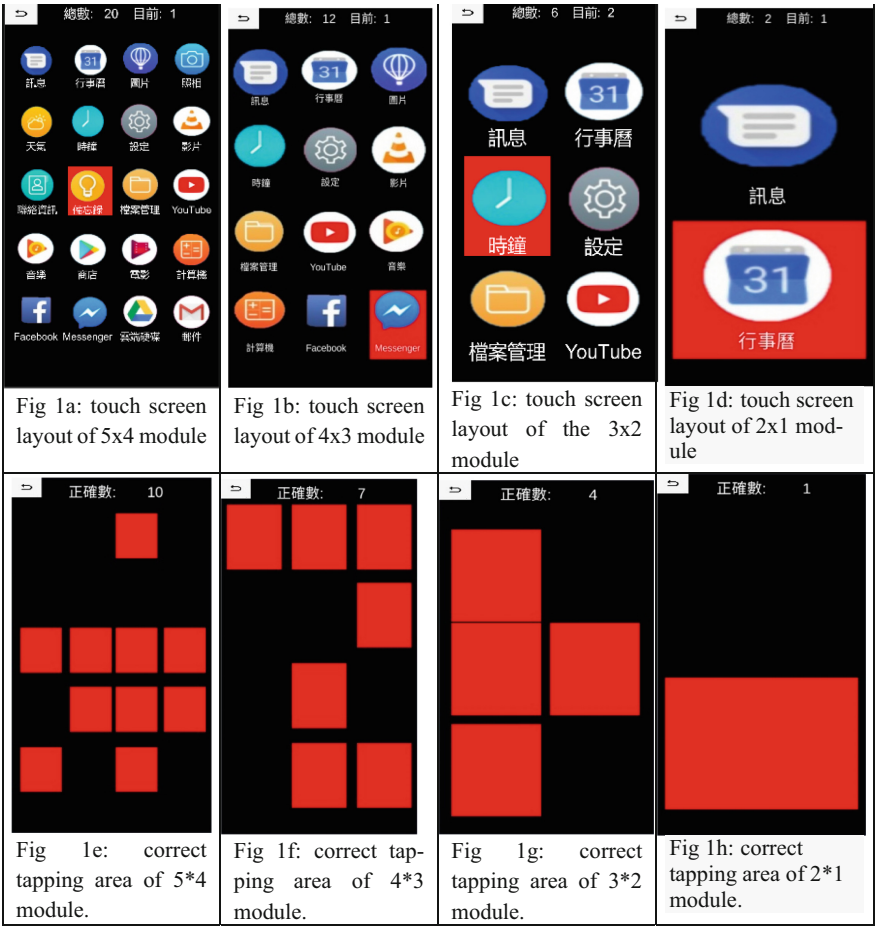

Fig 1a: touch screen layout of 5x4 module

Fig 1b: touch screen layout of 4x3 module

Fig 1c: touch screen layout of the 3x2 module

Fig 1d: touch screen layout of 2x1 module

Fig 1e: correct tapping area of 5*4 module.

Fig 1f: correct tapping area of 4*3 module.

Fig 1g: correct tapping area of 3*2 module.

Fig 1h: correct tapping area of 2*1 module.

Fig. 1. (a) Touch screen layout of 5 × 4 module. (b) Touch screen layout of 4 × 3 module. (c) Touch screen layout of 2 × 1 module. (d) Touch screen layout of the 3 × 2 module. (e) Correct tapping area of 5 * 4 module. (f) Correct tapping area of 4 * 3 module. (g) Correct tapping area of 3 * 2 module. (h) Correct tapping area of 2 * 1 module

are arranged in 4 columns and 5 rows (Fig. 1a). The subjects will be asked to tap on the flashing icon on the screen continuously; and the time of completion of tapping tasks, accuracy and the area of correct tapping were recorded (Fig. 1e–h). For instance, the Fig. 1e indicated the correct tapping area of the 5 * 4 module.

3.2 Slide

This sliding test simulates the action of the person turning the page left or right or moving the page up and down on the mobile devices. In this test, the screen shows four arrows in different directions: up, down, left, and right. The subject will be asked to slide from button to top (up, Fig. 2a), from top to button (down, Fig. 2b), from left to right, (right, Fig. 2c) and from right to left (left, Fig. 2d) on the screen. The accuracy, the time to complete the tasks, and trajectory of sliding will be recorded.

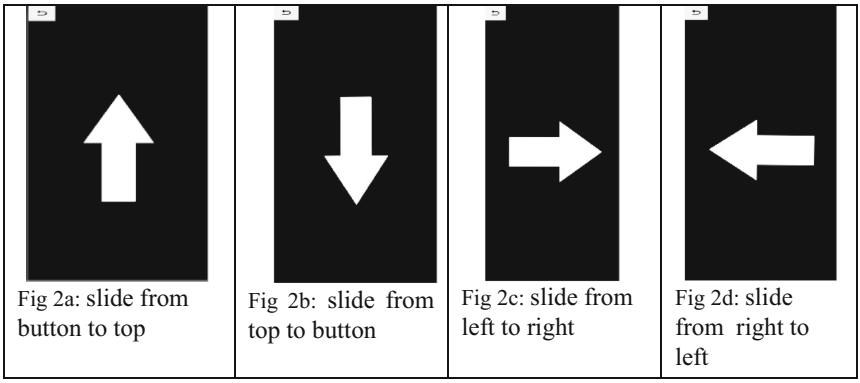

Fig. 2. (a) Slide from button to top. (b) Slide from top to button. (c) Slide from left to right. (d) Slide from right to left

3.3 Drag

"Drag" refers to holding the target on the screen and dragging the target to the specified location. In the drag test, the subject will be asked to drag from the blue line on the bottom to the red line. Four tasks, dragging from button to top (Fig. 3a), from top to button (Fig. 3b), from left to right (Fig. 3c), and from right to left (Fig. 3d) on the screen were tested. The location where the subject first touched the screen, and the distance and trajectory of dragging, as well as the time to completion will be recorded for further analysis.

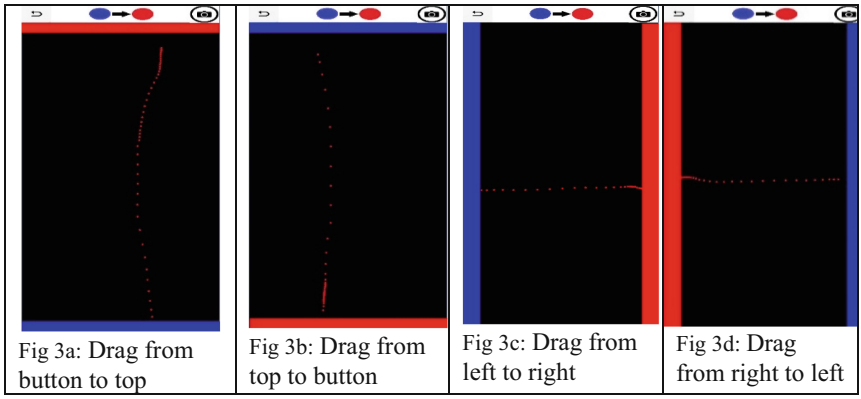

Fig 3a: Drag from button to top

Fig 3b: Drag from top to button

Fig 3c: Drag from left to right

Fig 3d: Drag from right to left

Fig. 3. (a) Drag from button to top. (b) Drag from top to button. (c) Drag from right to left. (d) Drag from left to right

4 Discussion

The AAS has been developed, and it seems suitable to evaluate the operation performance of mobile devices for persons with physical disabilities. Through the three functional evaluation tasks of the AAS, we would be able to understand the proper icon sizes, and the controllable area of touch screen on their mobile devices for the individuals with physical disabilities. For further studies, we will test AAS within different diagnoses of persons with physical disabilities, including cerebral palsy, spinal cord injury, and muscular dystrophy to look at their operational performance on the mobile devices.

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