ACCESSIBILITY DESIGN GUIDELINE FOR THE ELDERLY A CASE STUDY OF TV REMOTE CONTROL

Poonsak, T[1] and Teeravarunyou, S[1]

[1]School of Architecture and Design
King Mongkut's University of Technology Thonburi
126 Phachauthit Road
Thungkrui
Bangkok, Thailand 10140
Corresponding author's e-mail: rw010@hotmail.com, isaknyou@kmutt.ac.th

Abstract: The number of elderly population in the world is rapidly increasing. The elderly encounters a difficulty to operate new technology in their daily life especially television which play as an important appliance in their daily activities. This research was conducted to study the difficulty of the elderly while using TV remote control, to design the remote control that easier for the elderly than ever, and eventually to summarize the guideline of remote control that take advantage for future study. This research consisted of 3 sections that be; firstly, the pilot test was set up to compare the usability of control type in efficiency stand point among knob, slide bar and button type. Secondly, the elderly behavior on TV remote control was studied by participatory design method. Result in the outcome which be categorized into 5 criteria which are form, function, layout, grouping, and user feedback. The goal of this study leads to physical model creation in order to evaluate and compare their operation efficiency for further design and improvement of TV remote control for the elderly. Regarding to evaluating results of 5 criteria, the most popular remote control formation is trapezoid shape, mid-concave thickness, and two columns of buttons, border grouping, and sound back-alert. New style of TV remote control obviously shows that there are increasing in efficiency and understanding of functions among the elderly. In Additional, comparing to the existing style, the error is significantly reduced. Moreover, this study also provides useful information for designers, or manufacturers to create the better TV remote control or apply for further research.

1. INTRODUCTION

From Office of the National Economic and Social Development Board, it has been predicted that in 2010, the number of elderly population in Thailand will increase to 7.6 millions or 11.4% of overall population. Japanese Standard Association (JIS, 2000) starts set up standard guidelines for elderly products such as JIS S 0011:2000, JIS S 0012:2000 and others. From an observation of the elderly's behavior during watching a TV, it was found that they have many problems while using a remote control. The buttons, for instance, were too small to press. Most elderly had a big thumb, so it was relatively difficult for them to press and locate their fingers on a certain button on the remote control. The functions and information of the remote control are overloading and make them difficult to memorize. There are four main sections of the remote controller: menu of channel selection, navigation key, volume-channel buttons, and screen adjustment buttons. Those tend to cause difficulty rather than convenience. There is some product in the market that designed for elderly such as SilverPhone (Communic8 Ltd, 2004). The company produces a phone "Easy 5" with only seven big buttons that can memorize the telephone number. Although the usability of the phone increases, the flexibility of product is low. As a result, this research is an attempt to create a design guideline for designers with the constraint of existing remote control without changing much in term of functions.

The research aims to create a design guideline for elderly products. The objectives are:

- To study an interface design in term of cognitive ergonomics by using a remote control as a case study.
- To find out an effective interface design such as a form, function, layout, grouping and feedback that meets the elderly's needs. Then create a recommendation of design guidelines for designers.

This research consisted of 3 sections starting from pilot test, participatory design and experimental study respectively.

2. RESEARCH METHOD

2.1 Pilot Test

The pilot test was set up to compare the usability of input device types in efficiency stand point among knob, slide bar and button type as can be seen in Figure 1. The study was set up to verify which type of input device is the best for the elderly when they operate the TV remote controllers. The elderly was assigned tasks to change the TV channels. To control the variables, only 10 channels are used. At the beginning, eye sight test had been conducted to all participants to verify that all of them have a good sight. Then each participant had to perform the same exact task on all three types of remote controls by changing channels according to the assigned sequence which is 3,5,7,9,11,3,5,7,9, and 11. When all participants were working the assigned task with all three types of remote, each participant performance was recorded by using a camcorder. Then all of data was compared and evaluated in order to get a result.

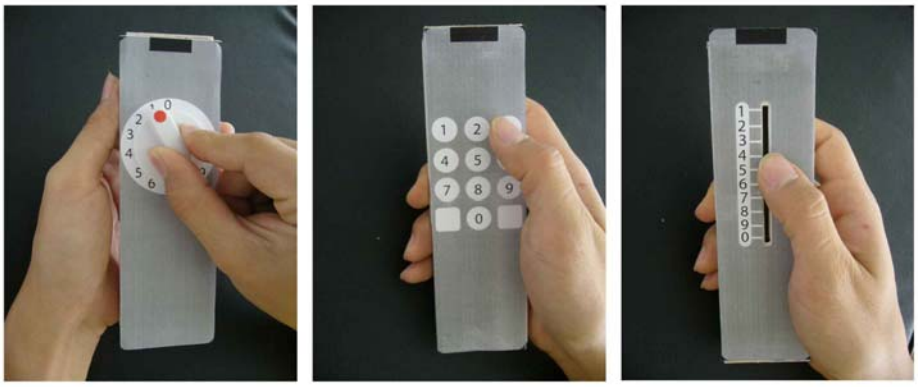

Figure 1. Three types of the remote controls

From the experiment, participants who are elderly can operate a remote control by using three types of the input devices but they mostly preferred the menu-selection. One of the main reasons is that they are familiar with the operation of this type for a long time ago. Moreover, this kind of input requires less finger motion. In addition, they are more familiar with it and it is relatively flexible when selecting channels. It is also more convenient, easier to control the speed and easier to learn comparing to the knob and slide types. As a result, only the menu button is used in the participatory design.

2.2 Participatory Design

This method is used to allow participants sharing their valued ideas and experiences in the design process that reflects their needs. The objective of this study is to analyze the idea and attitude of elders. The process starts from asking elderly to design a remote control with a preset material such as buttons, boxes, and labels as can be seen in figure 2.

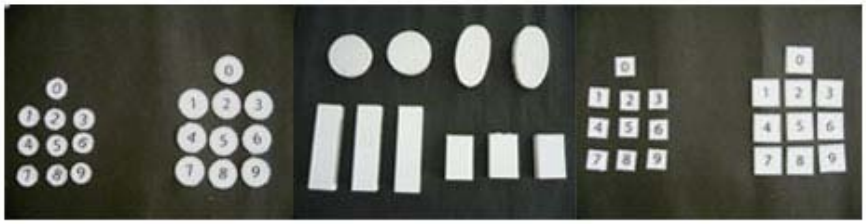

Figure 2. The shape, size of buttons and font size

The elderly were assigned to design a remote control that fits them (figure 3). They were asked to choose a paper box then paste and arrange the lay-out of buttons. They are allowed to put additional functions that fulfill their needs. After they finished the task, they were requested to present their result in front of a researcher.

Figure 3. Remotes designed by elderly

The result from participatory design shows that the elderly selects a small size shape that fits to their palm, because of easily grab and simple lay-out. Moreover, some of them create an inclinable body for the best signal sending, integrated microphone and light feedback. Then this information was brought to setup the experimental study. The criterions for design are form, functions, layout, grouping and feedback.

2.3 Experimental Study

Since there are many design varieties of remote control, there is no guideline for the designers to understand which remote control is appropriated for elderly. The following design criteria points out the initial problem.

Design Criteria

1. Form of remote control – the existing remote is too large and small font. The remote control should easily to grab, perceive and hold ergonomically.
2. Functions – most of elderly make a mistake of operation in pressing the wrong button. The remote control should reduce an error and easily to operate
3. Layout of menu selection – The elderly needs to memorize and navigate through the location of buttons since there are approximately 19 - 30 buttons. The layout of the menu selection could help to improve user memory.
4. Grouping – Elderly requires a button grouping in order to see the function of them clearly.
5. Feedback – Most elderly does not know the outcome of their actions. For example, they do not know that the channels they press since the indication of TV channel is too small.

2.3.1 Form of Remote Control

The researcher studies 12 styles of remote controls that are popular in the market. Those remote controls can be a model of study. The size of remote controls can be classified into two categories, width and thickness. Widths of the remote control are subcategorized as small, large and trapezoidal. The average sizes of them are illustrated in the figure 4. Thickness of the remote control is divided into 4 subcategories, thick head- thin tail, concave, thin head-thick tail, and flat, respectively. The objective of this part is to find the most suitable shape for elders. The proper shape in this study is based on the width and thickness of the TV remote control that the elderly can grab comfortably. The testing procedure is that the elderly stamped their fingerprint with ink on white papers marking on the remote control. Then, researcher collected distance data for further comparison and analysis.

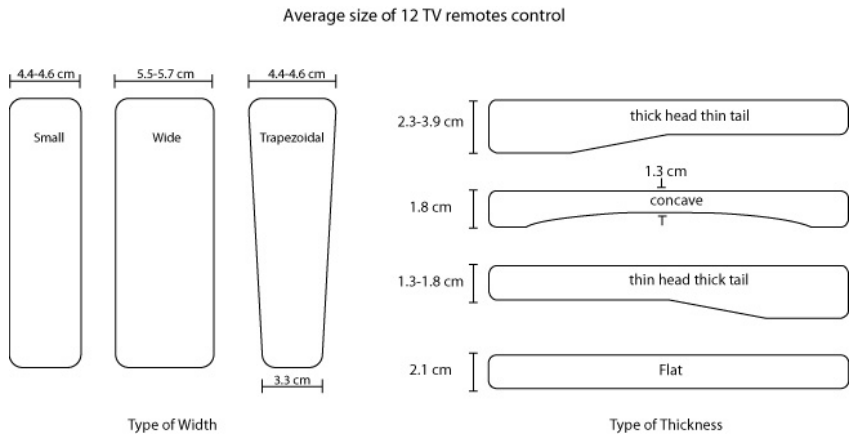

Figure 4. Average sizes of the above12 remote control

Figure 5. Elderly pressing his fingers on the paper

2.3.2 Functions of Remote Control

Two of input devices such as button and toggle are used in the experiment. The objective is to find the functions that mostly reduce error during operation by comparing the error between button and toggle type of menu-selection. Both of them are connected to the microcontroller as a data logger. The elderly must operate the remote control according to the voice command from the computer. Then the data is collected when the elderly pressed or toggle the buttons as shown in figure 6.

Figure 6. Elderly testing on type of menu-selection

Second experimental set was conducted in order to find out errors from using two types of input devices which are toggle and button types. This experiment was conducted in the same group of fifteen subjects. In this experiment, designed equipment was set up for testing with participants. There were ten sets of tasks to be accomplished by each subject. Total point is 10 for every subject who had done all ten given tasks correctly (by pressing the button according to the order written in paper). One Point will be deducted if participants fail to accomplish each given task.

2.3.3 Layout of Menu Selection

The objective of this testing is to figure out how elderly find a way to memorize the numbers according to the layout of buttons when changing channels and relieve eyesight trouble. Layouts are adapted from many layouts of products and redesigned by researcher. Researcher explains objective and procedures, and then elders understand the layout and count the numbers. In this experiment, seven lay-outs (figure 7) were randomly selected from interface typically used in appliances such as 1)Rectangular, 2)Circular, 3)Numeric key of touch telephone, 4)Vertical one line, 5)Vertical two lines,6) Zigzag, and 7)Horizontal one line lay-out.

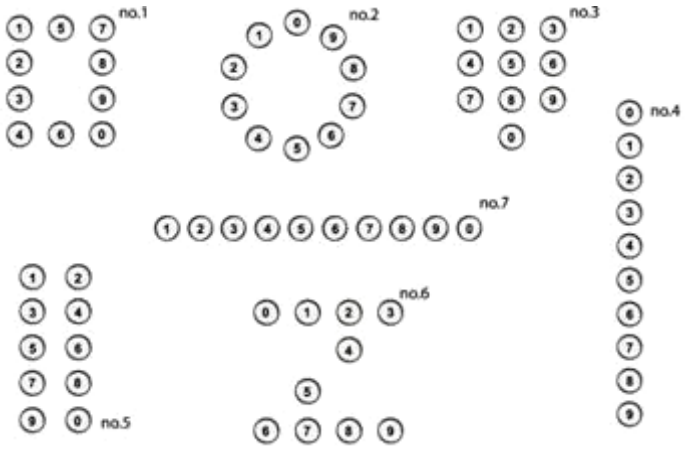

Figure 7. Seven layout of buttons

2.3.4 Grouping

From the study about highlighting, researcher designs five grouping of graphics on TV remote controllers that elders feel the most comfortable to operate as can be seem in figure 8. The buttons are grouped by shapes, color, border, area and none. Each participant was tested once at a time; there were 5 remote controls that had different types of grouping. Each remote was showed to the participant then ask subjects to verify the number of grouping button to see how they could obviously divide. Also we had participant to select the best grouping base on his/her thought. Then answers from all participants were taken to evaluate to find the best grouping. The method that had been used to get the best grouping was conducted as follows.

Figure 8. Button grouping of interface style

Fourth experimental set was conducted in order to find out the best buttons grouping that is easiest to be remembered by elderly. There were total 5 set of grouping schemes for subjects to choose from. One subject can select only one set of grouping that is easiest to recognize. This experiment was conducted on the same group of 15 elderly participants.

2.3.5 Feedback

For this experiment, the interface of remote control was tested with a touch screen display. Subjects can press the button on the touch screen then the feedbacks were activated. There are three types of feedback. The first feedback displays a digital number on screen while participants press the desired numeric button from number zero to nine (Fig 9a). The second feedback displays the blinking LED lights located above the each button(Fig 9b). The light will appear around 1-2 seconds. The third feedback is a human voice (Fig 9c). The remote will speak out the name of button after participant pressed the desired button.

a)Numeric feedback b) LED feedback c) Human voice feedback

Figure 9. Types of feedback in remote control

Fifth experimental set was conducted in order to find out the best feedback that can assist elderly to use a remote control more effectively. There were total three types of feedback for subject to choose from. One subject can select only one type of feedback that can help them to use remote control more effectively. This experiment was conducted on the same group of 15 subjects.

2.4 Population

Our experiment was conducted with 15 Participants, 9 males and 6 females who age over 60. They are able to solve a problem their ability without any assistant from other people. To select participant for this experiment, subjects are interviewed to check his/her physical condition first. Some the elderly can not perform our experiment such as deaf, blurred vision, Parkinson, and hand control. After 15 participants were screening, orientation of the study is introduced first. We also gave them a short period of time to get to know researcher. This experiment was set up at Lumpini Park, Thonburi Park and Suanthon Village.

3. RESULTS

3.1 Experimental Results

Field experiment was set up with total fifteen elderly participants. They are 10 males and 5 females who are over 60 years old. The test was conducted every 3 days a week for 3 weeks. This experiment was divided into four experimental sets. Each set of experiment was conducted with different testing equipments in order to find the design guideline of remote control. Approximately, subjects spent thirty minutes to complete each experiment. Five minutes are used to describe the experimental equipment. Ten to fifteen minutes are used to conduct the experiment. Ten minutes are for retrospective interview. The locations of testing are at Suan Lumpini Park, Suan Thonburirom Park, Thana Village Home and Garden.

3.1.1 Experimental of Hand Controls

The first experiment was conducted to test the farthest distance that fingers of elderly can reach the buttons on the remote control. To obtain the result from this experiment, two groups of forms are width and thickness.

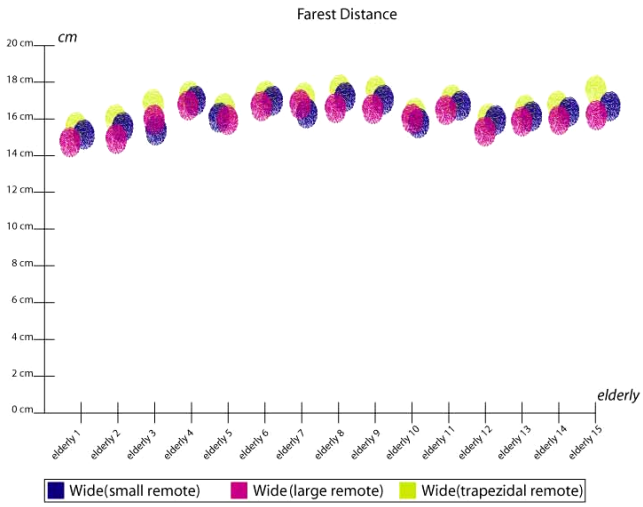

Figure 10. Farthest Distance (wide) remote controllers

Figure 10 shows that trapezoidal shape remote control has the highest distance or the farthest length that elderly finger can reach. It is 17.8 centimeters. After testing, we conducted an interview on each participant about feeling that they have while using each remote control. From interviewing, the result shows that trapezoidal shape is the one that participants feel the most comfortably and confidentially when holding it in their hands. Participant also gave their opinion that trapezoidal shape remote control might be the best one that fit to our human palm.

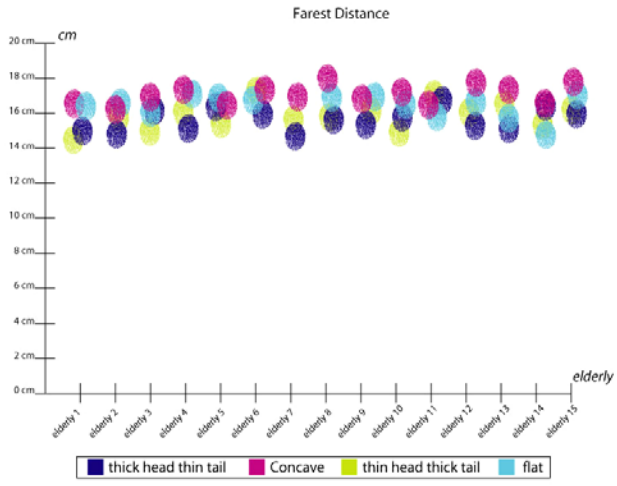

Figure 11. Farthest Distance (Thickness) remote controllers

Figure 11 shows that the concave shape has the highest distance which is the farthest length that elder's finger can reach. It is 18.1 centimeters. Subjects told that concave shape is the best one that fits to every palm of participants. They feel confidentially when holding remote control in their hands.

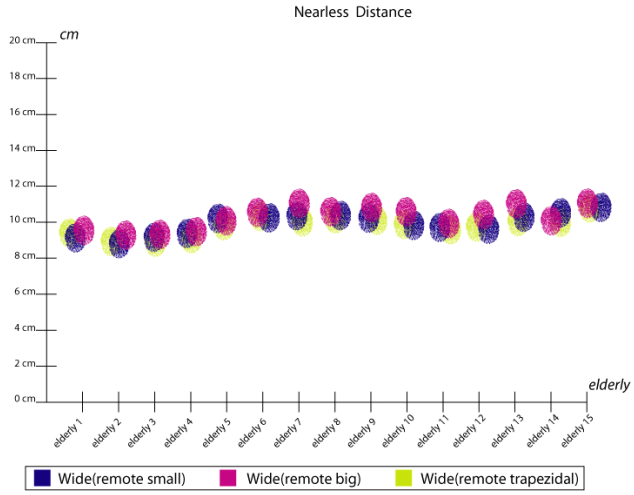

Figure .12 Nearest Distance (wide) remote controllers

Figure 12, shows that trapezoidal shape remote control has the lowest distance. The shortest length that elderly finger can reach is 8 centimeters. From interviewing, result shows that trapezoidal shape is the one that participants feel most comfortably and confidentially when holding it in their hands.

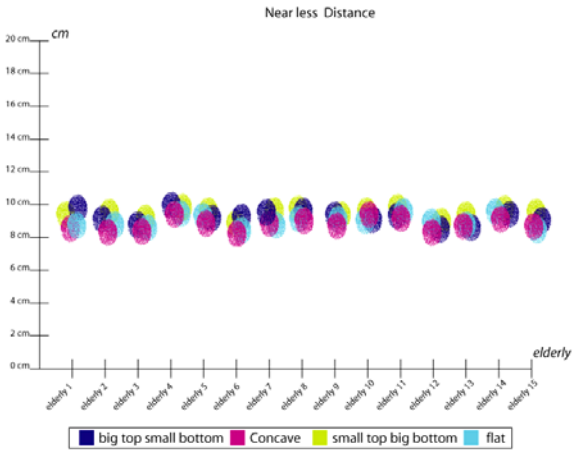

Figure .13 Nearest Distance (Thickness) remote controllers

Figure 13 shows that a concave shape remote control has the shortest distance that elder's finger can reach. It is 8 centimeters. The concave shape is the one that can easily fit to every palm of participants and make them feel confidentially when holding the remote control in their hands. According to results showed in the figure 4.1, 4.2, 4.3, 4.4, it can be concluded that the best shape of remote control that finger of elderly can reach is the concave one. The width and thickness is a trapezoidal shape remote control.

3.1.2 Experimental of Input devices

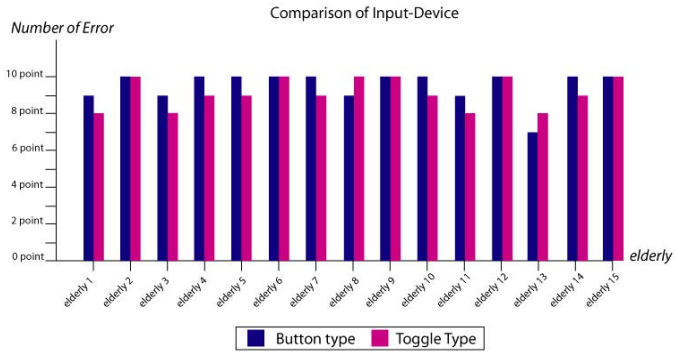

Figure 14. Comparison of Errors caused by using of Button and Toggle type

Figure 14 shows the number of errors caused by using of Button and Toggle type from each participant. It also shows that subjects did errors on toggle type 13 times and on button type 7 times. Therefore, it can be concluded that button type is better than toggle. Most subjects are experience with the button styles. With a short period of time for this experiment, it is difficult to change elderly's attitude of a new toggle style. Therefore experience of users impacts the way subjects use the product.

3.1.3 Experimental of lay-out

Third experimental set was conducted in order to find out the most satisfaction of button lay-out. There were total 7 lay-outs for participants to choose from. One participant can select only one lay-out that they satisfy with. This experiment was conducted on the same group of 15 elderly participants.

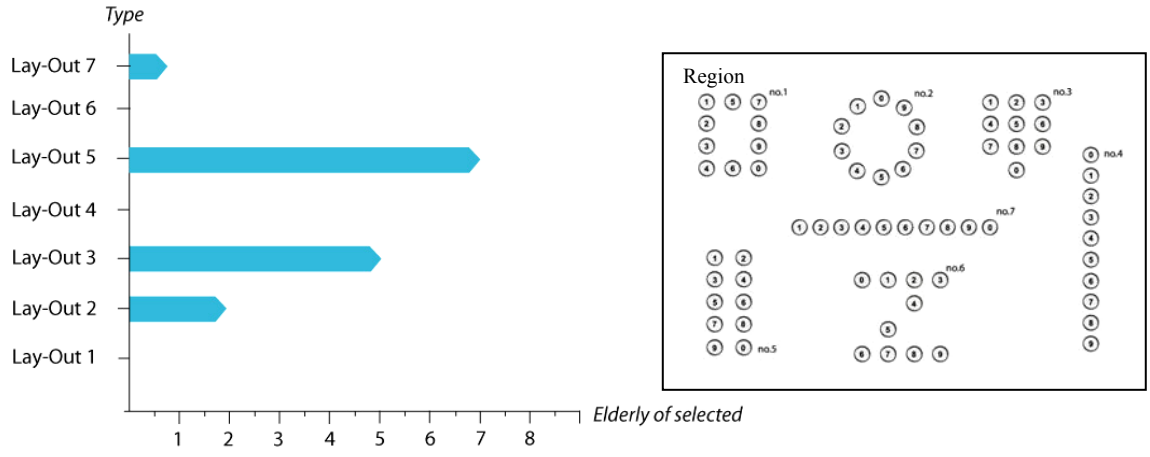

Figure 15. Selected Lay-Out by elderly

According to data from figure15, it can be seen that the most selected lay-out is number 5 which is chosen by 7 participants. This can be concluded that Lay-out 5 is the most satisfied lay-out. The elderly decide to choose two column buttons, because the new alignments of number buttons are easier to understand and more appeal to use.

3.1.4 Experimental of grouping

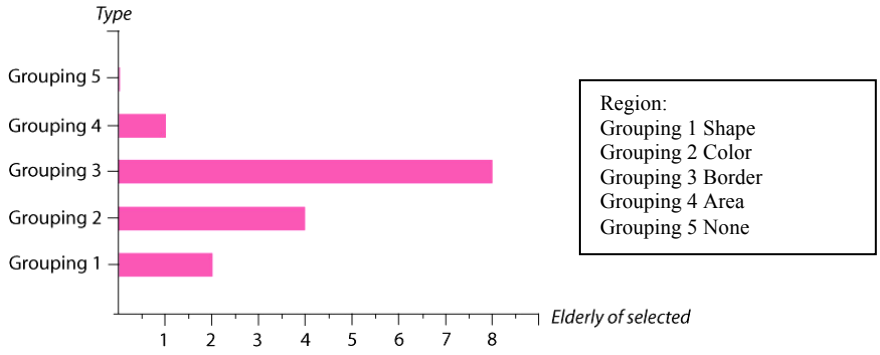

Figure 16. Selected grouping by elderly

According to data from figure 16, it can be obviously seen that the most selected grouping is the grouping number 3 which is chosen by eight participants. The border is better than other grouping significantly due to the color lines obviously group buttons which make the elderly effectively select correct buttons. It can be obviously seen that color assists the grouping. Grouping by border is more clearly distinctive than grouping by color. This can be concluded that grouping by border is the easiest one to be remembered by the most of elderly.

3.1.5 Experimental of feedback

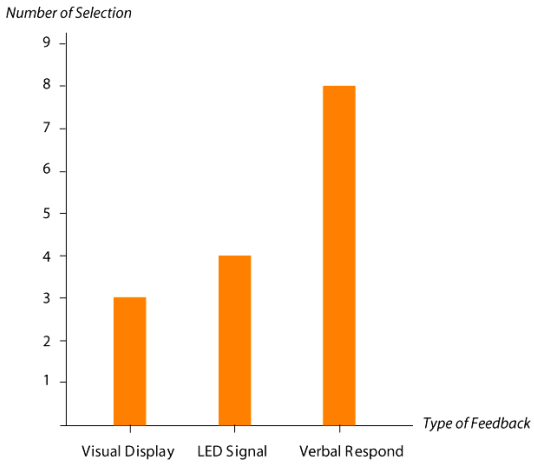

Figure 17. Selected feedback types by elderly

According to data from the graph in figure 17, it can be obviously seen that the most selected type is Verbal respond which is chosen by eight subjects. This can be concluded that verbal feedback is the best feedback that can assist elderly while using remote control. From interviewing, subjects reported that they selected the verbal feedback so they do not need to see the remote control. On the other hand, visual display and LED signal are overloading tasks due to elderly needs to share their attention resources to TV screen.

Five experiments are leading us to create an appropriated design guideline on remote control for elderly. First experiment was begun with exploring a proper taxonomy of input device, randomly selected from market-wide remote controller and internet sources. Three possible models were selected for evaluation by elderly. During pilot testing period, behalf on interaction to that particular model was observed, plus recorded motion video for reviewing later on. The result showed that the most appropriated characteristic of remote control chosen by elderly which is a menu-selection type. After preliminary testing was done, the next step was aimed to explore on the most proper menu-selection for elderly. In second experiment, participatory design method was used to find out problems. The results could be taken to consider as a

design criteria. The result shows that the trapezoidal shape and concave thickness are the best form of remote controls. The elderly prefers the buttons on remote control and suitable for grasping. For the function, the button type should minimize the errors from usages. Moreover the two rows pattern type is the best which can help elderly to remember and understand easily. The border grouping is the best for helping them to distinguish functions on remote control. Furthermore the elderly have the best response to verbal feedback type. The experimental results show that the feedback should be a combination of visual of TV screen and verbal respond respectively. To illustrate how design guidelines work, the 3D model in figure 5.1 shows as an example of product. It is a combination of five design guidelines.

Figure 18. Example of product from design guidelines

In addition, they might have other factors that can cause results to come out in different ways or causing other types of error. For example, the human scale can be studied with an anthropometric method. Additionally, “time” is important variable to show the error in Function testing. For the Lay-out arrangement and grouping, experts recommended that the result from the human performance is better than finding satisfaction. Finally feedback testing by using TV display together with the testing tool helps to obtain precisely response value from elderly. All of that are recommendations for future design and research. Moreover, it is not easy to change interface style because the elders were familiar with the old one for a long time. Another generation of elderly might change the attitude of using menu-style. In conclusion, the authors hope that the Design guidelines of remote control can be applied to other products in the future such as mobile phone.

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