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Design of Mobile Finger Communications Board for Stroke Patient Using The Five Planes of User Experience

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Abstract. Stroke, in 2014 to mid-2015 is the first cause of death in Indonesia. The condition of stroke patients whose movements are limited is exacerbated by the psychic condition of patients who are unable to communicate pressure will cause obstacles to the healing process of the patient. This research is designed based on the five planes of user experience which are divided into five areas: strategy, scope, structure, skeleton, and surface. This communication board is operated using the patient's fingers so that it is comfortable for everyday activities. The result of Mobile Finger Communication Board implementation shows that application usability level seen from perception and ergonomic point of view shows satisfaction index of the user at the satisfactory level so that it can be said that the system works with the satisfactory result of the users. It is expected that with the Mobile Finger Communication Board which will be used daily to support the healing process of stroke so that the healing rate of stroke is increasing.

1 Introduction

Stroke has become a phenomenon in Indonesia. In the 1990s, stroke was the fourth leading cause of death. However, in 2014 until mid-2015, this disease became the first cause of death in Indonesia. This is of particular concern to the Ministry of Health so that the prevention, treatment, and prevention of stroke are further enhanced. [1]

Based on the trend of stroke in Indonesia, it is necessary prevention and cares well. In general, prevention efforts are done from diet, rest, and exercise. While stroke treatment is done through care to hospitals, polyclinics, and traditional herbal medicine. The percentage of healing stroke is dependent on the condition of stroke. Also, perseverance, tenacity and the willingness of patients to heal also contributed the percentage of healing stroke.

The condition of heavy stroke patients who can not speak, limited movement and even paralysis will cause their own barriers for patients, families and outpatient treatment processes to the hospital. The condition of stroke is exacerbated by the psychic condition of the pressure of the patient who is unable to communicate, unable to walk even dependent by the family member or caregiver causing the stroke handling to belong. Therefore, it needs support to the condition of the stroke patient

so that the treatment and healing process can run smoothly so that the healing rate of stroke is increasing.

Support for severe stroke patients who are unable to communicate, can not walk, paralyzed and dependent on family members or caregivers can be through the procurement of a tool to assist the communication activities of stroke patients. Research says that communication boards have been proven to reduce frustration with communication. Patients have specific ideas about what terms and ideograms are useful for communication boards. A communication board is effective in reducing frustration and in facilitating communication. More specifically some advantages of communication boards are improving the efficiency and speed of communication, facilitating needs, and facilitators to gain recognition of patient individuality [2].

There is a technology outside the field of health but can support health and provide a positive influence of mobile technology. Mobile technology can support health services beyond the scope of the hospital for chronic and degenerative diseases [3]. Mobile technology can also be used for people with disabilities where they can not talk and use their hands to control an app. Implementation of mobile technology is located on Head Movement Controller System (HEMOCS) [4]. HEMOCS implements a new customized keyboard layout design based on the alphabet usage frequency in English and Range of Motion (ROM) to observe reactions from HEMOCS users [5]

Based on the need for stroke and stroke patients support, in this research a communication media of stroke patients, especially patients with difficulty speaking conditions is proposed, limbs are difficult to move and require the help of others. This research applies human-computer interaction (HCI) technology and Mobile Finger (MOFI).

This study was used to help non-verbal communication of stroke patients so that patients and people around can do daily activities well. With better communication then the information will be well received. The use of communication boards with the help of the patient's finger swipe does not complicate the limitations of patient movement so that it is comfortable to use for every day and the process of healing or stroke recovery can run smoothly. Use of communication board with the help of a patient's fingers or tap. This is because stroke patients have limited motor movement and can only move their fingers only.

Communication board design applies the principle of user experience which process is divided into five areas: strategy, scope, structure, skeleton, surface. From the previous description, the purpose of this study is to design a communication board for non-verbal communication media of stroke patients, apply communication board usage in stroke patients and analyze communication board performance from usability side of stroke patients.

2. Literature Review

2.1 Communication Board

A communication board is a board used to communicate, especially for patients with certain diseases. In this communication, a board is provided features that represent some of the daily activities of the patient. One example of the communication board shown in Figure 2 below is the Vidatak EZ Board communication board, which was patented in the United States in 1999.

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Fig 1. Communication Board Vidatak

The illustration of the board shows the existence of four important parts, each of which has some icons that represent the actions of a particular patient. These four sections include the "I AM" section indicating the patient's current state, then the "I WANT" section indicating the desired request by the patient, the "I WANT TO SEE" section indicating the patient's desire to meet with someone, and finally is the "KEYBOARD" section where the patient can designate a number of characters, either alphabetically or numerically as a patient's misspelled means to be understood by others.

2.2 Activity Daily Living (ADL)

Activity Daily Living is an activity doing daily routine work. ADL is an essential activity for self-care. ADL includes among others: toilets, eating, dressing (dressing), bathing, and moving places [9]. *Activity Daily Living* are the basic skills and occupational duties that must be possessed by a person to take care of himself independently of a person's daily work to fulfill or relate to his role as a person in the family and society[10]. Figure 2 shows activity daily living.

Fig 2. Activity Daily Living

2.3 Stroke

Stroke is a condition that occurs when the blood supply to the brain is cut off due to blockage or rupture of blood vessels, resulting in the death of cells in some areas of the brain. Stroke is a serious health condition that requires rapid treatment [8]. Aphasia is a syndrome of the nervous system (neurological) that impairs the ability of language. People who suffer from this disease will have difficulty in expressing the mind and finding it difficult to understand and find words while communicating. Of course, this will cause problems in the life of the sufferer. Therefore, communication is one of the important things in life. Usually, this disease will occur suddenly after you have a stroke or injury to the head. Aphasia is divided into three nonfluent aphasia (people who experience the disease will communicate using incomplete sentences but can understand what others are saying), fluent aphasia (people who experience this type of aphasia can speak fluently, using long sentences, complex, and often unreasonable and unable to comprehend the spoken language of the other person well), global aphasia (occurs when the language network of the brain has been severely damaged and widespread so that the sufferer will experience severe disability in terms of understanding and expression). Based on these three types of aphasia, the study used a patient belonging to nonfluent aphasia or motoric aphasia.

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2.4 User Experience (UX)

According to Jakob Nielsen, user experience encompasses all aspects of user interaction with the company, its services, and its products. User Experience (UX) is an experience made by a product to people as its users in the real world [6]. UX is not simply a chain of work within the product or service that is the main thing in the product. User Experience (UX) focuses more on functions outside the product when in direct contact or contact with the user. The design used in this study is the method of analysis by using The Five Planes based on research [6] about user experience. The user experience development process is all the processes that ensure the user understands every action taken and understands the user's expectation for each action to be performed. The user experience development process is divided into five areas namely strategy, scope, structure, skeleton, and surface. The user experience development process is done from the bottom up.

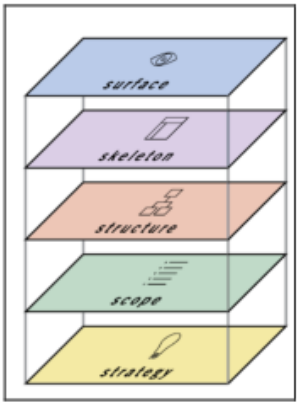

Fig 3. The Five Planes of User Experience

3 Design of *Mobile Finger Communication Board*

Mobile Finger Communication Board usually refers to Activity Daily Living or daily activities are always done that is eating, bathing, wearing clothes, moving places, to the toilet and the streets. In addition to daily living activity, this application also refers to the Board of Health Communication made by the company VIDATAK called EZ Picture Board. There is also a menu to represent the feelings or something that complains the user is the pain, dizziness, cold, heat, fear and sadness. When the user selects the action he wants, the system will play the sound of the selected action through the speaker on the device. In addition to choosing an action, users can also write words that consist of a certain number of characters. If he makes a mistake in entering a character, he can erase his character. Users can also play the sound of words that have been compiled through the speakers on the device.

The data collected is then analyzed using a user experience process consisting of five steps (the five planes), namely strategy analysis, scope, structure, skeleton, and surface. Followed by the analysis using user design method which consists of understanding and determining the user context, determining the needs of users and organizations, resulting in design solutions, design evaluation of user needs, data collection and observation. Data collection is done through interviews and observation. The interview was conducted by a neurologist at a hospital, as a source who knew about stroke as well as doctors who deal with stroke patients. Also, interviews were also conducted with patients in each home, accompanied by family members and conditioned as comfortable as possible according to the instructions of a neurologist. Observations are made on stroke patients who are implementing communication boards using a single finger touch (tap), double-tap double touch, and swipe to the right and left. Duration of interview and observation for each patient ± 30 - 45 minutes.

Respondents were selected based on Purposive sampling technique with the qualification of the respondent test is respondent have aphasia complaint due to the history of stroke disease; respondent has experience using a mobile device, respondent can read picture or writing (not illiterate). From these qualifications, the selected test respondents are the users with aphasia complaints due to stroke diseases both male and female, amounting to 10 people.

Table 1. Demography of Respondents

Respondents = 10	
• Age	> 40 th = 10 and < 40 th = 0
• Gender	Female = 4 and Male = 6
• Work	Farmer = 5 Entrepreneur = 1 Employe = 2 Housewife = 2
• Long Occurrence of Stroke	> 1 year = 7 < 1 year = 3
• Intensity of Mobile Device Use	Often (≥1x/ day) = 9 Rarely (≤ 1x/3-7 day) = 1

3.1 Requirement Analysis

The requirement analysis is divided into two parts: functional and non functional requirement. System functional requirements are necessities that represent what things the system can do. The functional requirements are shown in Table 2.

Table 2. Functional Requirement

No.	Req. Code	Functional Requirement
1.	SRS-MCB-01	The system provides daily life menu choices and complaints to be communicated by actors.
2.	SRS-MCB-02	If the actor selects a particular action, the system must be able to play the sound of the action through the device.
3.	SRS-MCB-03	The system provides a keyboard to use for typing the word as the actor wishes.
4.	SRS-MCB-04	If the actor decides to play the word sound he has compiled, then the system must be able to play the word sound through the device.
5	SRS-MCB-05	Actors can replace or delete characters that have been typed on the system keyboard board

Analysis of non-functional needs is to get a specification about quality aspects required by the application. The non-functional requirement is shown in Table 3 :

Table 3. Non Functional Requirement

Non Functional Requirement	Description
Usability	Applications should be easy to use with a minimum usability level satisfactory (61-80%)

The actor identification contains the elucidation of the identification result of the actor who will identify with the User Experience Design System Stroke Communication Board. The system actors that can be identified as shown Table 4:

Tabel 4. Actor System

Actor	Description
User	Is a person who has limitations in communicating due to a disease. In this study, the user is a stroke patient with a difficult condition to communicate (aphasia)

3.2 Scope Design

The scope design or scope of the Mobile Finger Communication Board consists of several content needs that must be met. The content will be the viewing menu in the Mobile Finger Communication Board application and according to the user's needs of basic human needs (ADL), the usual complaints submitted by the patient, the patient's desire to meet someone, the patient's desire for entertainment / refreshment, patient ("Yes", "No", "OK", "Thank You").

3.3 Structure Design

In the design of structures, interaction design and information architecture are created. The structure field serves to determine the direction of navigation in an application and relates to the content available on the pre-made scope design. The structure design of the Mobile Finger Communication Board consists of several structures shown in Figure 4 below:

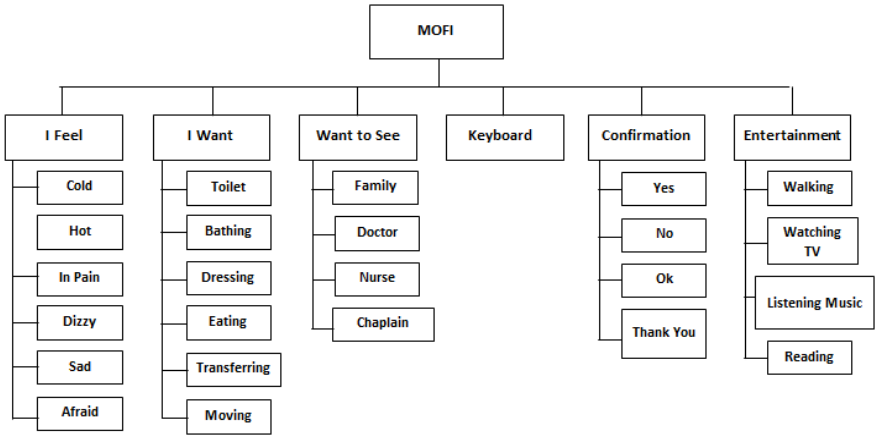

Fig 4. Scope Design MoFi Communication Board

3.4 Skeleton Design

Skeleton design is more emphasis on setting the location of elements. The following is shown in Figure 5 is one of the skeleton designs in the main menu MOFI :

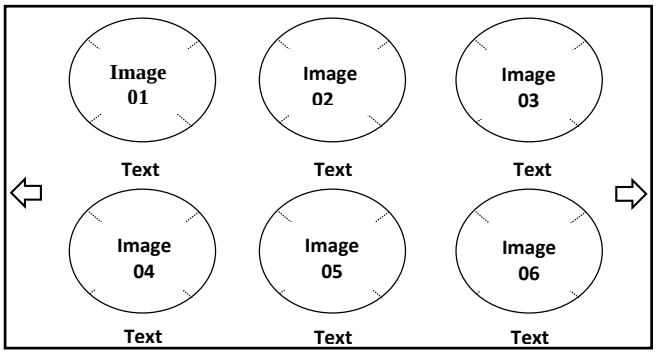

Fig 5. Skeleton Design of MoFi Communication Board Main Menu

3.5 Interface Design

One design of the MOFI Communication Board interface is shown in Figure 6 below:

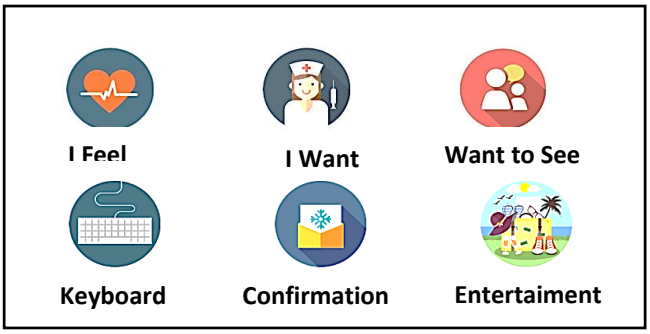

Fig 6. Interface Design of Main Menu

3.6 Control Design

The type of interaction that the user performs on the system is the type of interaction that is mediated interaction (mediated interaction) is done by using gesture movement (gesture). The action that can be done by the user against the system, among others, select the menu with a tap, shift the cursor arrow position of the page, choose a specific action, choose characters to compose a word, replace and delete characters. When a user is inside a certain page, he can move to the page position before and afterward by tapping the movements of his fingers or shifting (swipe) the screen with the touch of a finger.

3.7 Screenflow Design

Screenflow is a term that can be used to describe the flow of interfaces that occur within a system. There are eight screen displays which consist of MoFi.Apk Application, main menu, "I feel" menu, "I want" menu, "want to meet" menu, "keyboard board" menu, "confirmation" menu, and "entertainment" menu. The eighth view is a view of the interface compiler of the system to be developed. After the main menu, the user can select other menus as desired, then also can make a choice back to the main menu.

4 Implementation

Implementation of the system discussed, among others, about the explanation of the system specification, the limits in implementing the software, the application of method and application of user interface. The MOFI-controlled system is implemented into several mobile devices of different sizes (small, medium, large size), with the following specifications:

Table 4. Specification of Smartphone 1 (HP 4 inch)

No	Components	Specifications
1	Model	Samsung Infinite SCH-1759
2	Procesor	Dual Core 1.2 GHz
3	Memoryi (RAM)	786 MB
4	Capacity	4 GB

Table 5. Specification of Smartphone 2 (HP 5,3 inch)

No	Components	Specifications
1	Model	Sony Xperia T3 - D5103
2	Procesor	Quad-core 1.4 GHz
3	Memory(RAM)	1 GB
4	Capacity	8 GB

Table 6. Specification of Smartphone 3 (Tablet 7 inch)

No	Components	Specifications
1	Model	Treq-Call 3G
2	Procesor	Dual Core 1 GHz
3	Memory (RAM)	512 MB
4	Capacity	4 GB

The user's fingers touch the screen of the device once in a short time with a range of icon menu size. If the user uses a finger tap with a long touch time, then the voice response that appears will be too late. If the user uses double finger tap with long touch time or more than twice, then the system will be too late to respond to the sound. The user's finger shifts the screen (swipe) of the device once with the widest range of menu screen sizes just to slide to the right and to the left. When the user shifts up or down the system can not respond to the action. Sound processing on MoFi using Google Text to Speech. Figure 6, Figure 7 and Figure 8 show the view of the MoFi menus that are implemented on mobile devices:

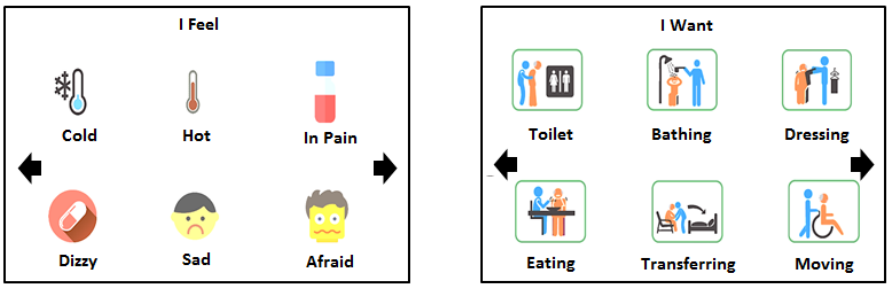

Fig 7. Interface Design of "I Feel" and "I Want" Menu

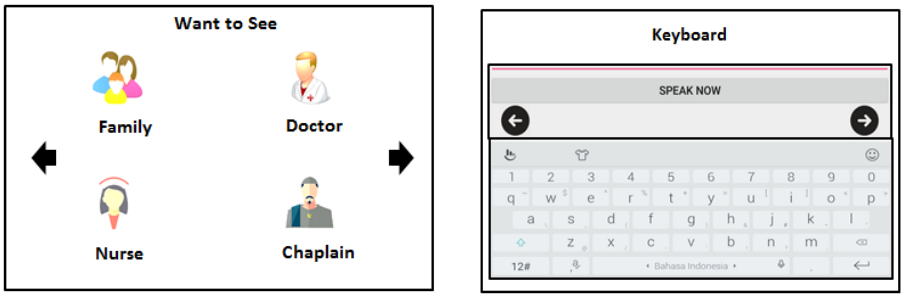

Fig 8. Interface Design of "Want to See" and "Keyboard" Menu

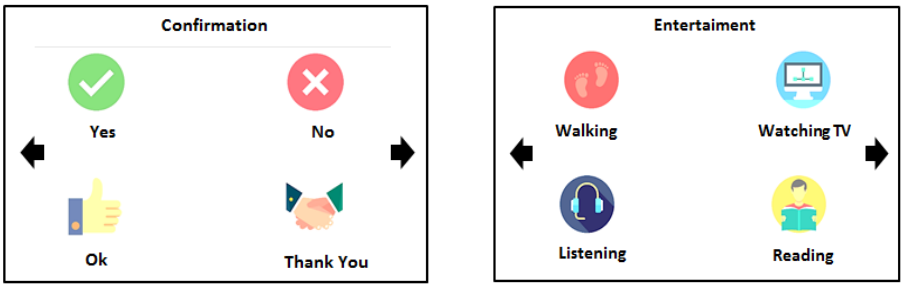

Fig 9. Interface Design of "Confirmation" and "Entertainment" Menu

5 Evaluation

The evaluation will be discussed functional testing and nonfunctional testing. Functional testing is a test conducted to determine whether the system has been implemented by functional requirements that have been defined in the beginning. The system requirement to be used in this test comes from the functional requirements previously written in Table 1. This functional testing method is done by using the black box, and functional requirement will be tested using some test cases. A good test case can represent all possible pathways that users can make to the system. From the test cases obtained results that the whole functional testing has been valid. This means the system has successfully done the task of switching positions, sound management, display images, and text. The following is the result of functional testing of the application:

Table 7. Functional Testing Results

NO	Testcase Code	Expected results	Results obtained	Status
1.	TESTCASE-MCB-001	This system can move the position of the menu from the main menu position to the position of the sub menu selected.	The system successfully moves the position of the main menu to the position of the selected sub menu.	Valid
2.	TESTCASE-MCB-002	The system can make a sound according to the menu selected on the device	The system managed to make a sound according to the menu selected on the device	Valid
3.	TESTCASE-MCB-003	The system can display user-selected characters in text field located on the "Keyboards" menu	The system successfully displays the user-selected characters in text field located on the "Keyboards" menu	Valid
4.	TESTCASE-MCB-004	This system can display typed words and simultaneously make sound according to the word order.	The system succeeds in displaying the typed wording and simultaneously making the sound according to the wording.	Valid
5.	TESTCASE-MCB-005	This system can remove the typed word character on the keyboard board.	The system successfully deletes the typed word character on the keyboard board.	Valid

Non-functional testing is a test conducted to determine the quality and to the system that has been implemented. The parameters to be used in this non-functional testing process are device control parameters and usability parameters. MoFi control method uses fingers when choosing application menu. Based on the results of the control tests of each device then obtained a device control analysis that amounted to 74% for the device control score 1, which is classified as a satisfaction category.

While in device 2, obtained a control score of 75% classified as a satisfaction category, and on device 3, obtained a score of control of 81% which classified the category is very satisfaction.

The next non-functional testing parameter is usability, which is the parameter used in testing the level of user satisfaction regarding the use of the system that has been developed. This test is done by testing the system that has been developed directly to some respondents. Respondents will be asked to fill out a questionnaire containing some statements related to the convenience and ease of use of the system. The statements to be used in this research questionnaire come from previous research titled "*Toward Standard Usability Questionnaires For Handheld Augmented Reality*" [11] where the research discusses usability measurements on the use of mobile device technology on Android. Classification of questionnaire result consist of very unsatisfaction (0-20%), not satisfaction (21-40%), neutral (41-60%), satisfaction (61-80%) and very satisfaction (81-100%).

Table 8. Questionnaire

No	List of Questionnaire Statement
Related Statement of Application Usage Perception Problem	
1.	I think the amount of information displayed on the mobile device screen is appropriate
2.	I think the information displayed on the device's screen is easy to read
3.	I think that the information displayed has a quick response
4.	I think the words and icons displayed on the device screen are easy to read
5.	I think the information displayed on the screen is consistent
Related Statement of Application Usage Ergonomic Issues	
6.	I think interacting with this app does not require much effort mentally
7.	I think interacting with this app does not require much physical effort
8.	I think the use of this application is convenient to use my finger
9.	I find it easy to input information into the application
10	I do not feel my finger tired of using this app
11	I think the operation of this application is simple and not complicated

The result of usability parameter test of each device shows that on the first device average usability is 73,6% (satisfaction category), on second device average usability is 75% (satisfaction category) and on third device average usability equal to 81.4% (very satisfaction category). Of the three devices, the satisfaction index on the user perception aspect shows the highest score in the first statement that "the amount of information displayed on the mobile device screen is appropriate." Then the satisfaction index on the aspect of ergonomics of the use of the application shows the highest score on the seventh statement is "about interaction with the application does not require much physical effort." The overall test results show that the developed system provides satisfaction results to the users.

Table 9. Experimental Result of Device 1, 2 and 3

NO	Usability	Device 1	Device 2	Device 3
1	User Perception	73,2 %	76 %	80,8 %
2	Ergonomic	74 %	74 %	81 %
Total		73,6 %	75 %	81,4 %
Level of Usability		Satisfaction	Satisfaction	Very Satisfaction

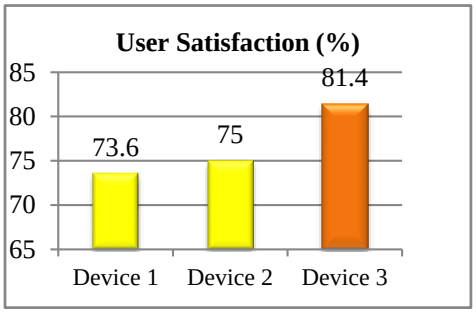

Fig 10. Experimental Result of Usability

Analysis of these results indicates that more app users feel comfortable when using a third device that is a tablet-smartphone with a larger screen size (7 inches) of the first device (5 inches) and second (5.3 inches). The results indicate the iterative that the greater the device, the more satisfaction. But from the aspect of practical use, if the device size is too large then the user will be more difficult and heavy to carry it. It can be said that for users, especially for patients, the use of applications on mobile devices can be tailored to the conditions, needs, and comfort of the patient. Mobile devices should not overload and reduce patient comfort. This is also reinforced by the results of the testing task completion :

Table 10. Task Completion Result

TASK	USER									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. User open MOFI app	S	S	S	S	S	S	S	S	S	S
2. User select one of MOFI main menu	S	S	S	S	S	S	S	S	S	S
3. User choose the menu "I feel"	S	S	S	S	S	S	S	S	S	S
4. System display sub menu "I feel	S	S	S	S	S	S	S	S	S	S
5. Users choose the sub menu "I feel" cold / hot / pain / dizziness / sad / afraid	S	S	S	S	S	S	S	S	S	S
6. The system plays the same sound according to the sub menu selected by the user	S	S	S	S	S	S	S	S	S	S
7. The user return to the main menu if you want to select another menu	S	S	S	S	S	S	S	S	S	S
8. Users want to communicate but there is no menu that represents, then the user selects keyboard menu	S	S	S	P	P	S	S	S	S	S
9. Users type a word through the keyboard	S	P	S	P	P	S	S	S	S	S
10. The user selects the "speak now" button to play the sound of the word you have a type.	S	S	S	S	S	S	S	S	S	S
11. The system plays the same sound as the words typed	S	S	S	S	S	S	S	S	S	S
12. Users want to replace/delete the wrong characters on the type word by returning to the keyboard and selecting the "delete"	S	S	S	S	S	S	S	P	P	S

Note: S (Success), F (Failure) and P (Partial Success)

6 Conclusion

This research proposes a stroke patient communication media by applying Mobile Finger Communication Board technology and designed based on five planes of user experience which are divided into five areas: strategy, scope, structure, skeleton, and surface. This MOFI is operated using the patient's fingers so that it is comfortable for everyday activities. The tests performed are functional testing, control testing, device testing and non-functional testing or usability testing. The results of the implementation and testing show that the application usability level in the three devices viewed from the perspective of perception and ergonomics are at satisfaction levels (devices 1 and 2) and very satisfaction (device 3) so that it can be said that the developed system gives satisfaction results to the users. For further research to make this application more developed features and tested again using some parameters of other users satisfaction to more respondents and more varied device sizes for more optimal results.

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