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Design and Development of Application for Post-Stroke Aphasia Using User-Centred Design Approach

Muhammad Hafis[1] and Farhan Mohamed[2]

[1,2]Faculty of Computing, Universiti Teknologi Malaysia,
81310 Johor Bahru, Johor, Malaysia
{akhiahmadhafis@gmail.com[1], farhan@utm,my[2]}

Abstract. Post-Stroke Aphasia one of the diseases that could be treated by using computerized methods. A method of implementation that focuses on improvements on human-computer interaction aspect of post-stroke aphasia treatment which focuses on user-centred design system development lifecycle. Emphatic design and contextual design are used as a user-centred design approach on human-computer interaction improvements. In this study, the system development follows the user-centred design workflow by doing a literature review and observation to get the problem statement, these is done to create a Hierarchical Task Analysis (HTA) for the design process of establishing requirements and storyboarding, the observation shows that post-stroke aphasia patients have difficulties on processing and comprehending words. The design process then developed into a prototype application that fits with such requirements in form of an Android Studio application integrated with voice recording for the patients. Finally the result is measured and compared with usability testing to see the user's satisfaction between the existing application and the developed prototype. Result shows that there is a significant increase in term of user's satisfaction on the developed prototype (Sys. Usability Score: 75.7) compared to the existing application (Sys. Usability Score: 24.6), Post-Study system Usability score also show that the developed prototype is also able to reach the user's satisfaction (on a scale of 0 to 100) in term of system usefulness (78.3), information quality (76.4), and user interface (82.6).

Keywords: Aphasia, Human-computer Interaction, User-Centred Design

1. Introduction

Post-stroke Aphasia is a form of disease which affects a person after affected by stroke, post-stroke aphasia treatment can be done by using technological means by using computer-based treatment such as flash card method as suggested by Mortimer (2006) and naming therapy as researched by Duncan, Schman and Small (2012).

Computer-based treatment for post-stroke aphasia can be improved by using user-centred design approach, user-centred design focuses on improving user interface of the said treatment application by using the user as the main reference for development lifecycle.

The purpose of this project is to create a mobile application for post-stroke aphasia patients by using user-centred design approach. This project targets to study and identify the problems and gaps of post-stroke aphasia patients by developing a post-stroke aphasia mobile application by using user-centred design approach and analyse its qualities by evaluating its performance after deploying it. The development of the application focuses

on expressive and anomic aphasia patients only, the prototype developed for this research will be on Android platform only, the development focus only on speech therapy, and the development phase is until the testing phase only/

This paper is organized as follows: In section 1, the introduction of this paper is presented. Then on section 2, some related works are explained. Section 3 provides the methodology that is used in this research. Next, the result is discussed on Section 4. Section 5 presents the discussion of the results obtained in the testing and finally, Section 6 provides the conclusion of this project.

2. Related Work

The usage of computer science on treating aphasia has been done since around almost 20 years ago, Roth and Katz (1998) mentioned that the computer can be an effective clinical tool by incorporating what commonly known about aphasia treatment and computer programming. Computers can administer activities designed by clinicians, vary stimulus characteristics, adjust response requirements, present cues, and select tasks, all in response to patient performance. Many supporters of computers as a clinical tool focus on relevant issue such as cost effectiveness and operational efficiency.

Jokel et.al. (2006) done a research on computer-based intervention for anomia by using MossTalkWords (Fink, Brecher, Montgomery, & Schwartz, 2001; Fink, Brecher, Schwartz, & Robey, 2002) on non-fluent aphasia. Their study found that computer-based treatment for anomic aphasia are beneficial and suggests that computer-based treatment may be a viable therapy approach as it has a potency on increasing effectivity of traditional aphasia treatment. Sandt-Koenderman (2011) mentioned that computer technology has been incorporated into treatment options. A key indication for good prognosis is treatment intensity. A minimum of two–three hours per week has been specified to produce positive results. The usage of computer on therapy is that the intensity of the therapy can be increased. Computer acts as a supplement, an additional exercise which complements the traditional method with therapist, creating variety and increase dynamics of the treatment. Sandt-Koenderman (2011) also mentioned that computer technology seems to be limited in a communicative setting, however it is effective in producing improvements in communication training.The usage of computational method for aphasia treatment can be implemented by using multimodal procedural computerized therapy of both spoken and written treatment (Weill-Chounlamountry et.al. 2011). By analysing naming disorder symptoms on aphasia patients, naming deficit and word finding disorder were improved on efficacy and generalization to untrained words. This also supported by Duncan, Schman, and Small (2012) by using repetition therapy, their research founds that computer-based therapy found to be effective in enhancing repetition skills both on older patients and younger patients.

There does exist several computer-based treatment applications for aphasia treatment. Most of them are on mobile device as computer-based treatments by using desktop device reduce effectivity especially for severe post-stroke aphasia which may include physical disabilities (Gowland 1993). Computer-based treatment speech therapy methods may include but not limited to: object recognition, object comprehension, object repetition, sentence repetition, sentence completion, sentence comprehension, object memorizing game, word finding game, and sentence matching game. Most existing applications use

phoneme-based articulation and phoneme-positioning (initial, medial, final) articulation on object-related methods, meaning the applications focus on a single phoneme usage on several words based on the choice of articulation and position. For instance, the phoneme /b/ is chosen as an articulation while initial is chosen as the position, the words that may be used on this particular therapy may include words such as baby, beach, and ball. If the chosen position is medial, words such as marbles, rabbit, and rubber may be used. Another common method used is flash card method, a method developed on 19th century as a literacy educational method (Mortimer, 2006), the original flash card is used for educational and memorization purpose for learning drill commonly by students. In aphasia treatment, objects are classified based on their phonemes. From a computing point of view, an object may be put as a class consist of object name, object sound, object picture, object phoneme, object details, phoneme location, and sentence example.

By synthesizing and combining the methods and field related to aphasia, a solution is created for an ergonomic applications by using user interface design and user experience design of human-computer interaction methods using user-centred design with mobile-application approach with an implementation of emphatic design and contextual design for aphasia patients. An application developed with user-centred design may be more effective to post-stroke aphasia patients because the needs and requirements are tailored based on a particular user needs.

3. Methodology

This section presents the methodology used in this project. Figure 1 illustrates the project methodology involved from the identification of needs and requirements until evaluation phase.

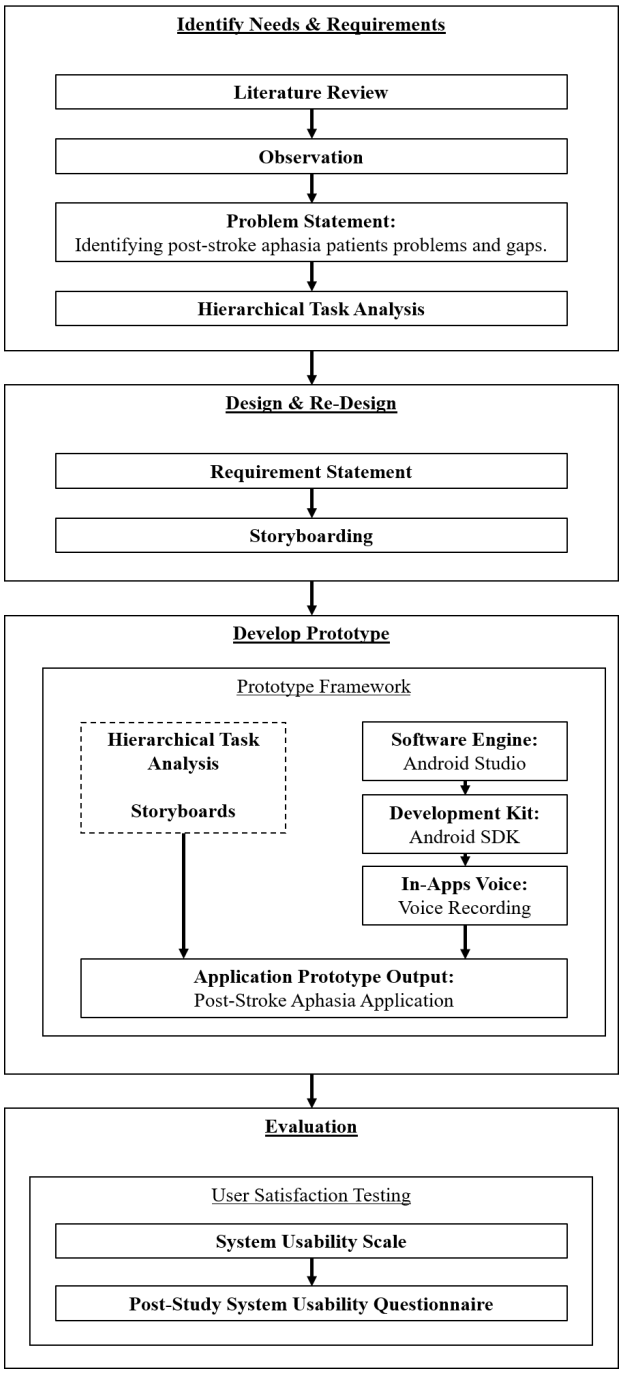

Figure 1 Project Methodology

4. Result

In this project, User-centred design system development lifecycle is implemented to improve usability by removing complexity for the targeted user, in this case, post-stroke

aphasia patients. User-centred design is implemented by incorporating emphatic design and contextual design as shown on figure 2.

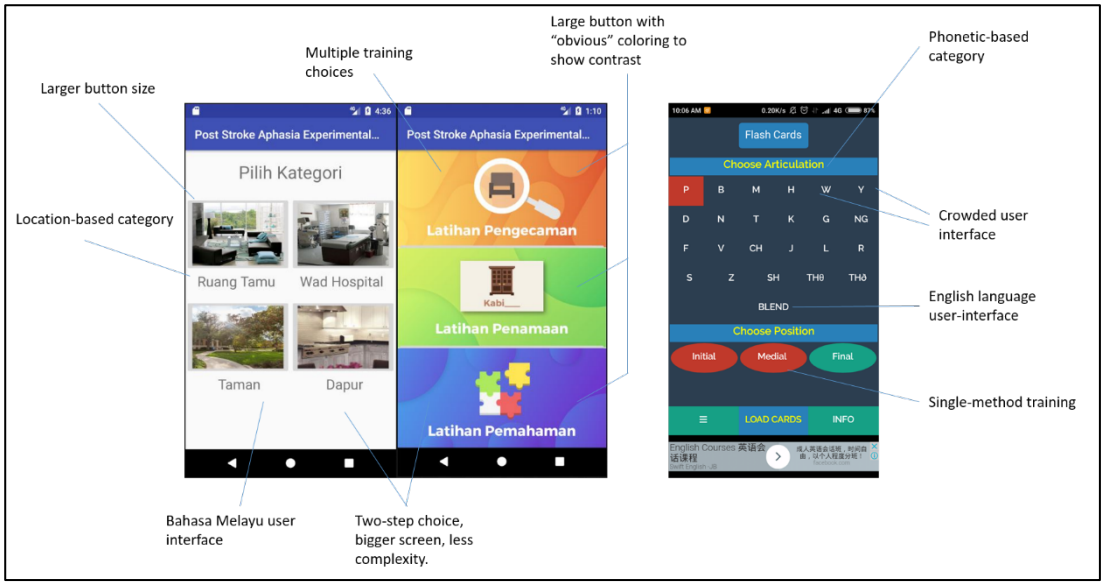

Figure 2 Comparison between developed prototype and existing application.

A larger button size improves usability compared to crowded user interface, especially for post-stroke aphasia patients, even more important for patients with physical impairments, contrasting colour is also done to show difference between choices. Location-based category compared to phonetic-based category, thus the user can relate to the objects and items easier and get a more relatable sentence due to muscle memory on that particular location, moreover, phonetic-based category may have unrelatable objects that cannot be easily understood by the patients, the main goal is consistency and full understanding, not cramming information of uncommon objects towards the patient's mind.

Multiple training method is done to ensure the patient's understanding on a particular object, a two-step choice is created to reduce complexity for the user, instead of putting everything on a single screen that might reduce the usability of the application due to crowded user interface.In this project, the testing is done by applying System Usability Scale (SUS) test and Post-Study System Usability Questionnaire (PSSUQ) test to measure the performance of the prototype. The test is done by comparing two application, one is the existing application for aphasia, and the other one is the prototype. On this performance testing, SUS is done twice, one for the existing application as a benchmark, and one for the experimental setup, the sample size is 20 users.

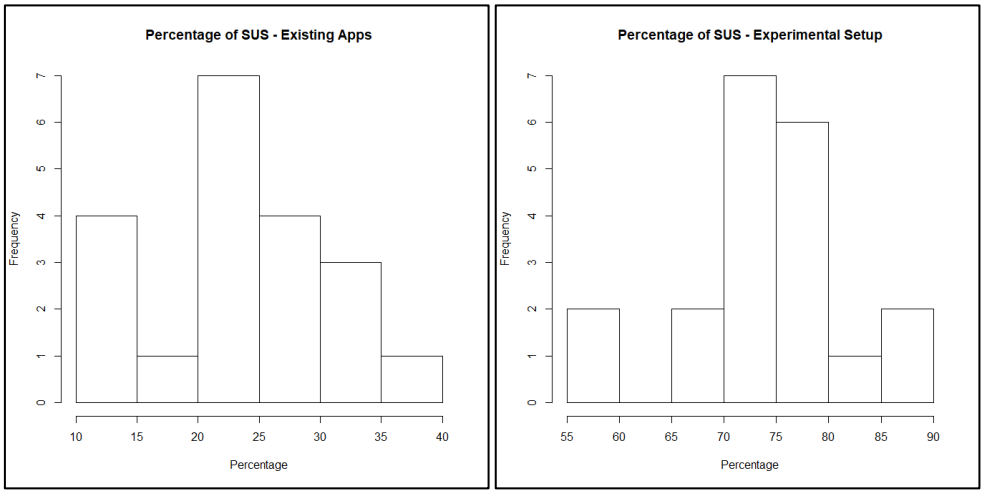

Figure 3 SU Value of existing application VS SU value of experimental setup.

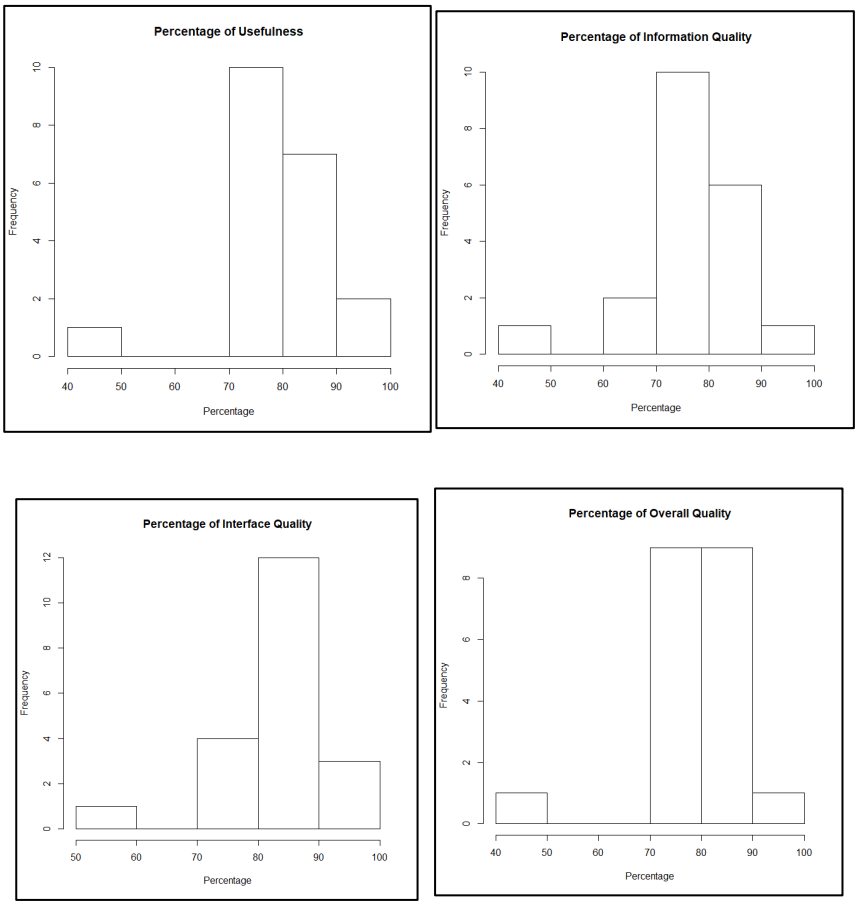

Figure 4 PSSUQ Histogram of Experimental Setup

Figure 3 depicts the result of SUS test on existing application and the experimental setup while figure 4 depicts the result of PSSUQ test on experimental setup.

5. Discussion

Based on the results on figure 3 and figure 4, the prototype shows a significant success on improving the usability compared to the existing application, whether in term of plain usability, usefulness, information quality, interface, and overall performance, from the graphs, the improvement targeted has been reached and the objective of this research has been accomplished.

6. Conclusion

In this project, the usability of application for post-stroke aphasia is analysed by implementing user-centred design to the prototype developed, and then compare its result to the existing application. Based on the result that are obtained, the result suggest that user-centred design should be implemented to create a proper environment to improve usability and user experience of the users. Therefore, the project objective, aim and purpose has been reached. For future improvements, an extra input modalities such as voice recognition and voice data storage can be applied to further improve usability, performance measurements should also be done thus the quality of method can be further evaluated., while also providing further reference for future researches.

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