Game Based Approach for Memory Rehabilitation Therapy in Stroke Patient

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ABSTRACT

Stroke can attack anyone and can cause physical and cognitive problems. Cognitive problem is highlighted as we focus on memory games for stroke patients. All aspects of health game incorporation such as motivation, difficulties, animation, colour graphics, and sounds were extend the ability to present materials that encourage patient with the rehabilitation task. The objective of this project is to design and develop a game-based approach to memory therapy for stroke patients. One patient was selected as the target user for this project. The result was then analysed and evaluated.

Keyword: Stroke, Cognitive, Memory, Health game, Rehabilitation

I INTRODUCTION

Stroke is the collective name for several conditions that can affect the brain. Lack of memory processing is one of the brain problems among stroke patients. Patients are unable to memorize their own name, their family names, and certain past information, because of the lack of left brain function (Nurdan et al., 2010). They find it difficult to solve problems, even simple ones such as wearing clothes and other activities. They cannot interpret information clearly in the first place because of weakness in the function of accessing memory from their brain (Cynthia et al., 2013).

Currently, the function of serious games which in this case is to recover from bad symptoms among patients are popular (Luciano, 2008). It is because the attractive concept applied into the games which motivate patients to do the tasks without pressure.

Thus, our mission is to design and develop a game-based approach for memory rehabilitation therapy in stroke patients and to test the application with a clinician’s guidance.

II RELATED WORKS

Based on Green and Bavelier (2006), cognitive process modification occurs with gaming practice. Patients unexpectedly do exercises while playing the games and this can in turn improve their memory. According to Cynthia et al (2013), the game motivates the patient to perform the repetitive exercise needed for rehabilitation. Based on Alankus (2010), previous research has supported commercial “games as effective motivators for performing rehabilitation exercise”.

The important purpose of memory games to stroke patients is to activate some areas of their brain which can help in memory improvement (Susie et al., 2005). When a person plays memory and brain-enhancing games regularly, he or she will not only be able to enhance the brain's memory function, but also other brain skills like concentration, focus, attention level, cognitive skills as well as reading and reasoning skills. Therefore, this project will be conducted using a game based approach to help stroke patients in memory rehabilitation to enhance their brain function.

Based on Alankus (2011), there are many research projects that have been done to recover the symptoms of stroke patient using games techniques. The games that are related to our application are as below.

A. The Frog Simon Game

The patient remembers and repeats tunes. Figure 1 below shows that this game is a single-player game. It provides a level of challenges on the memory and requires an accurate 2D input. The player needs to click the frogs in order to recreate tunes that they played. This combination of difficult cognitive challenges and difficult physical challenges were impractical for stroke patients (Alankus, 2010).
A. Under the Sea

Figure 2 below show that this game is easy to play and require a somewhat basic vertical 1D input. The mother fish would train their babies; meanwhile the predator would come to eat the babies. The stroke patient would need to control the cursor vertically across the right side of the screen and prevent the predator from eating the babies. The patient needs to create a strategy to save the babies.

B. Screenshot of the Game

This game was designed and developed specifically for upper limb rehabilitation of stroke survivors. The function of this game is to increase the range of motion functional use of the impaired upper limb extremity, improving the motor recovery and to make their cognitive sense active. The patient needs to move their hand to control the cursor on the screen. Patient needs to locate the cursor inside the cell to select an image. Figure 3 below showed the game interface.

C. Jigsaw Puzzle

This game helps the patient to memorize the shape and place the pieces of a puzzle. The background picture is blurred to give the patient a hint to complete the game. This game will make their brain think on how to complete the picture clearly. The patient would need to move the cursor and drag the pieces of puzzle into one background picture. This game has several levels of difficulties to make the game more challenging. Figure 4 below show the game described.

III METHODOLOGY

Methodology is usually a guideline system involved in problem solving with specific components required such as project framework and game flowchart.
A. Project Framework

The framework in Figure 5 describes briefly about overall development of the project which consists of model design, game techniques, multimedia elements and interface design. The name given for this application is “Memory Box”. Table 1 explains four main screens for interactive Memory Box application. Each screen serves a different function inside the application and provides distinctive purposes.

<table>
<thead>
<tr>
<th>No</th>
<th>Screen Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Splash Screen</td>
<td>This screen act as a welcome page with attractive animation and loading page</td>
</tr>
<tr>
<td>2</td>
<td>Menu screen</td>
<td>This screen contains the subtopic of the subject. Users can choose among several options whether to know the description of the game, start to play the game or exit the application</td>
</tr>
<tr>
<td>3</td>
<td>Game Screen</td>
<td>This screen allows the user to start the game task</td>
</tr>
<tr>
<td>4</td>
<td>Result Screen</td>
<td>This screen shows the user’s performance based on his score and time taken to complete the game</td>
</tr>
</tbody>
</table>

The development project involved was Adobe Flash CS6 which was the most popular tool for game applications. Actionscript 3.0 is used rather than Actionscript 2.0 because it contains many new features and a great deal of performance that was not available in previous versions. This project starts with designing the application in Adobe Photoshop software. After that, all images were imported into Adobe Flash library.

This application used laptops or Personal Computer (PC) because of their special features such as a bigger screen and mouse interaction so that patients can make a hand movement when playing the game.

B. Flowchart

Figure 6 showed the game flowchart applied in this application. The flowchart explains every process of the game.

C. Screenshots

Upon completion of Memory Box application, it had been tested and worked smoothly.

This game allows users to find the two same images on the card until the entire card image appear on the screen. With this technique, it can help patients to improve their memory skill during they remember back the location of the related images. The family images on the card were to help the patients to recognize each of their family members.

Because the game specialises for one patient only, a box image showed at Figure 7 and Figure 8 are used as an assumption to save his family picture into the box. Menu interface at Figure 9 provide three options which are ‘play’, ‘how to play’ and ‘exit’ buttons. Figure 10 showed ‘how to play’ interface which describe the game rules to the user before they can start playing the game.
‘Play’ option brings the user into three levels as shown at Figure 11 below. The difficulties of the game were increased followed by other level until highest level of the game. The game interface for level 1, level 2 and level 3 are showed at Figure 12, Figure 13 and Figure 14 below. Figure 15 showed the result interface after the patient finishes each of the game level. The screenshots of application flow are as below.
We test the application based on the visual observation in terms of duration, score, eye-contact, and the way they complete the game levels. Every result is different for every level of the game. Thus, we can observe the patient’s improvement for each difficulty of game level.

IV EVALUATION AND DISCUSSION

Feedback is important in order to know the success of the application. The purpose of this analysis is to get feedback about the application whether it can recover the memory function to a stroke patient or not. All the information from the observation and interview with the patient are gathered and analysed below.

**Interest.** Patients were interested in holding the mouse in front of laptop. He played with the mouse by moving the mouse left and right after we give an instruction on how to use the mouse. He also showed an interest to complete the level.

**Game Interaction.** Apply the buttons ‘play’, ‘how to play’ and ‘exit’ to see the next page.

**Attraction.** Attraction towards the sound after the game started.

**Movement.** Control a cursor using the mouse button to play the game. However, he needs more time to handle a movement of the cursor.

**Thinking.** Try to memorize the image on the card and find the matching card.

**Feedback.** The patient gives a response when he saw the image coming out after a click into the card. Sometimes he looked into his wife when his wife’s image appeared on the interface.

While the patient uses this application, one doctor observed and evaluated the patient’s activity and document edit. Table 2 below showed the information documented by the doctor.
### Table 2. Doctor observation and evaluation.

<table>
<thead>
<tr>
<th>Lvl</th>
<th>First round</th>
<th>Second round</th>
</tr>
</thead>
</table>
| 1   | i) Patient difficult to handle the mouse because of the patient’s limb is not well.  
   ii) Patient takes 8 minutes to complete level 1 and gets a bad score.  
   iii) Patient still doesn’t recognize the image on the card.  
   iv) Patient’s focus is weak. | i) Patient can handle the mouse slowly and somewhat better than the first test.  
   ii) Time to complete this level is faster and the score is better than before.  
   iii) Patient slowly recognizes and tells the family’s name on the card that appeared after he clicked the card.  
   iv) Patient gives more focus to find the matching card. |
| 2   | i) Patients still slowly uses the mouse to move the cursor on the screen.  
   ii) Patient still takes a long time to complete this level.  
   iii) Patient’s focus is weak because the number of the card was increased. | i) Patient can handle the mouse much better, because he can recognize the right, left, up and down position of the cursor.  
   ii) Time to complete this level is faster and the score is better than before.  
   iii) Patient’s focus increased and looks more enjoyable playing the game. |
| 3   | i) More focus to find the same image of the card.  
   ii) Patient takes more time to complete the level. | i) Patients are more skillful in handling the mouse movement.  
   ii) Patient becomes able to recognize their family members by looking at the card. |

### V. CONCLUSION

The memory games application for stroke patient promotes the rehabilitation tasks using technology. This stand-alone application was suitable to be used at home and clinics as well as for independent tasks. Patients become more attracted to this application with the help of animations, sounds and moving pictures especially his family pictures. Patients enjoy playing the game and at the same time will improve their memory ability unexpectedly. This function fulfills the serious game objective which is to assist the patient’s health improvement.

This memory game application still needs to be improved to deliver a greater content and performance. There are few aspects that can be improved for future advancement such as provide more stroke patients to access the application. It can be done by creating different family pictures images for different patients. This technique can be done using database element which can save any kind of different data. Clinicians also can evaluate the patient’s improvement using quantitative techniques by saving the total score and time taken to finish the game into the database.

### ACKNOWLEDGMENTS

The authors would like to thank the Ministry of Education, Universiti Teknologi MARA (UiTM) and the Research Acculturation Grant Scheme (600-RMI/RAGS 5/3 (206/2013)) for sponsoring a part of this research.

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