

Labyrinth game with Kinect control

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ABSTRACT

Stroke changes not only the patients' lives, but also those of their families. The improvement of the active movement of the upper limbs is of great importance after stroke, which helps regain self-sufficiency and the recovery of fine movements. One of the key elements is the development of the active movements of the arm and fingers. The aim of the Flash-based labyrinth game of the article is to develop these motor skills, and that the patients may become self-sufficient in their home environment, or capable of working by the end of the rehabilitation. The Labyrinth Game is focusing on the movement of arms and elbows, out of the 17 exercises of Wolf Motor Function Test's (WMFT) upper limb rehabilitation tasks. The game uses simple forms and colours, and contains understandable and useable menus for more efficient usability.

1. INTRODUCTION

The aim was to develop and implement a labyrinth game so that patients will be able to continue their rehabilitation in their home environment to become self-sufficient, moreover get fit for work. Stroke can create occlusion of veins, or necrosis due to haemorrhage. The most common signs and symptoms are the lack of strength, hemiplegia, and the paralysis of upper limbs. There might be a disorder in movement co-ordination, which can result in vestibular disorder and inaptness of limbs. In case of damage of the dominant cerebral hemisphere, speech disorders, or in extreme conditions, even aphasia may appear. During the precession of the symptoms the patients require acute medical attendance. Rehabilitation might get started when the process stabilises and the unimpaired areas start to work again (Vogiatzaki, 2016).

The main element of the rehabilitation program is physiotherapy, which might be carried out actively, passively, individually or within a group.

2. STANDARD REHABILITATION METHODS

Researches claim that stroke patients taking rehabilitation at a home environment, with a positive atmosphere, are more likely to regain their individual life-style. Of course, rehabilitation and recovery highly depend on which part, and in what extent is the brain damaged. The aim of the rehabilitation for the patient is to re-learn the previously known skills and to recover self-dependence as much as they are capable of.

During active rehabilitation the patient completes the tasks independently with the help of a physiotherapist; having reached a certain level, they can continue rehabilitation at home to maintain their knowledge and up the level of rehabilitation. Recently, several methods and therapies exist and are available with the application of which a considerable improvement can be gained in post-stroke rehabilitation. With their appropriate usage, the recovery time might be shortened and the patients may return to their former life-style much earlier.

2.1 Support recovery with physiotherapy

One of the methods to speed up recovery is the usage of adequate physiotherapy. The slow and progressive movements should be carried out continuously, till the toughness of the limbs disappear.

2.2 Music therapy

Music, as a whole of characteristic vibrations, can achieve peculiar spiritual and physiological effects. As a therapy, the active and passive varieties of music are used. During active music therapy the patients are singing

or using musical instruments for the development of partial learning skills as concentration, memory or creativity. With the application of passive music therapy (receptive therapy) different areas can be improved with chosen music (American Music Therapy Association).

2.3 Pető method

Besides development of children, András Pető is dealing with the rehabilitation of function disorders in adulthood. As the plasticity of brain remains after childhood and adolescence, there is an opportunity in any age group to set up new cerebral connections. During the program the patients can learn movement coordination, correct posture, walking and fine motoric movements. If required, attention, concentration and communication might also be developed (Bandolier).

2.4 Rehabilitation with computer games

Stroke is physically, emotionally and economically demanding; the medical institutes do not have the opportunity to cater the patients during the whole rehabilitation process. 6 months after stroke, 80-90% of stroke patients still have problems with arm movements; however, the lost functions can be regained with the appropriate devices. There is a great need for serious games, with the help of which the patients can exercise in their home environments. These games help the recovery and development of patients without the continuous supervision of the therapist in a comfortable environment. With the application of rehabilitation methods the movement of arms and hands are developed independently, while with serious games both of them might be improved at the same time. Some of the games improve the coordination, accuracy and speed of the arms and hands (e.g. Plasma Pong), other simulations develop the accuracy of finger movements and grabbing (e.g. Virtual Piano). The application of serious games shows decisive improvement; the impaired limbs became more stable. Thus, it has been proved that the usage of rehabilitation games, with 2-3 hours of practice at home environment might improve the conditions of patients (Burke, 2009).

2.5 Rehabilitation results with active games

Rehabilitation researches with video games show that during their recovery the patients retrained the lost strength and motoric functions of their limbs within a shorter time thanks to the games.

In a research – aimed for stroke rehabilitation – the results showed that repetitive exercises help the development of arm and hand functions of stroke patients. In the test the users had to touch virtual objects in a virtual environment. Patients taking part in the testing were completing tasks in the virtual environment with a help of a robotic arm. After the 2 weeks long testing period the results showed that the patients could move their arms much quicker thanks to the repetitive movements, than before the therapy. Despite using robotic arms for accomplishing the tasks, the results showed that the number of connections between different brain areas had increased. The results are enticing; the robotic arm assisted physiotherapy and virtual reality might help in the recovery of stroke patients (Laino, 2010).

2.6 Limitations of home rehabilitation

Despite the help of physiotherapists and families, due to the fact that the recovery is ill-progressing, during the rehabilitation, patients suffer from changing moods, a negative attitude toward the treatments, or passivity (Legg, 2004).

It needs to be taken into account, whether the patient can fully complete the tasks mentally and physically. If the task is too difficult or too much for the patient he/she might get exhausted. If they cannot complete the tasks they might get disappointed, and because of the negative experiences they might lose the interest in the games. This way the rehabilitation will not progress well and will not have good results.

3. LABYRINTH GAME WITH KINECT CONTROL

In the article the design and implementation of a computer-based rehabilitation game will be presented. The game is set up of 2 fields: in the first one the patient has to collect a number of objects from different places on the field based on the given level of difficulty; in the second field they have to create a meaningful word of the given letters. At the realization of the game it had to be taken into account that the program is dedicated for the rehabilitation of stroke patients. In this case an easily applicable game with rich visual and audio background had to be developed that the patient can easily use and enjoy every day to help their recovery. Another important aspect of the program was to cover the tasks of WMFT, which do not require special devices or weights for the completion of the exercises.

Another important aspect was to use peripherals that are available for everyone (such peripherals were searched for, which are available for every user, or can be purchased easily for a low price). The game needs to inspire the patient for moving, this way it needs to be funny, but challenging at the same time. An easily applicable and understandable surface has to be created, so that it can be used by everyone despite the age groups.

3.1 *First steps – requirements specification*

The task was to design and implement a Flash based labyrinth, where the player first has to gather the treasures on the field of the labyrinth, and after it – in the next field – they have to create a meaningful word out of the letters, the number of which equals with the number of treasures.

In the development of the program the arm, elbow and shoulder movements of the WMFT test have been taken into consideration. The aim of the game was to cover as much exercises of the 17 movements as it is possible. If it is possible, the program – besides using a mouse – has to be controlled by a sensor device as well. During the research no solutions were found for the problem of connecting PHP based webpages and control them with Kinect sensor, this way the idea had to be rejected. A programming language needed to be found that supports the usage of several sensors.

3.2 *Choosing peripherals*

As the program was designed for the rehabilitation of stroke patients, such devices had to be chosen that are available in most of the households, or can be easily obtained. During the examination process several devices were found which can be connected with a computer and are supporting rehabilitation.

As a first periphery Mouse had been chosen. It is cheap and available in nearly every household. After connecting it to the computer it is adjustable, so even right- or left-handed people can use it. Although the Mouse can only be controlled while sitting on a horizontal surface, the arms, hands and fingers of the patients are still moving, this way the exercises cover several tasks of the WMFT movements. It is multi-platformed so it is supported by all of the basic operating systems.

As a second device, Music Glove has to be mentioned. This device is appropriate for the therapy of stroke patients, or patients of brain or muscle damage (Caswell, 2015). During the use the patient has to move his/her fingers for music, as in the case of Guitar Hero game. With this game fine movements of hands and fingers can be practiced and also helps the recovery of cerebral neurons. The patients using the device for 2 weeks have reported a decisive improvement. Unfortunately it is not available in Hungary, but it can be easily purchased from online webshops, however, because of its price (which is around \$1000) the device is not suitable for home rehabilitation.

Webcameras are relatively common because of their low prices; they can be used from great distances. Unfortunately, they cannot be used for rehabilitation processes, as they were not designed for tracking movements, thus they cannot accurately locate the limbs. For this problem Kinect sensor is the solution. Microsoft has created Kinect sensor for Xbox games; in the device sensors of microphones and cameras can be found. It has been created for home use. It is a medium-price device. With the suitable drivers it can be used by any computers. The game was finally developed to be controlled with the two most suitable peripherals, the Kinect sensor and the Mouse. For the development a previous version of Kinect, Kinect v1 was used with a 1.8 developer toolkit.

3.3 *Labyrinth game*

After choosing from 3 different levels of difficulty – beginner, intermediate and advanced – the player can choose from 6-12 previously edited fields. The program creates the field size suitable for the level of difficulty, places the walls on the field and the objects that have to be collected. The player has to practice the exercises of WMFT movements, which do not require special devices or weights. The sideward, vertical and diagonal movements of the arms can be practiced as the player has to pass by the vertically and horizontally placed walls on the field. The navigation between the objects to be collected can be completed by the vertical and horizontal movements of the arms.

3.4 *Labyrinth game level editor*

The player chooses one of the 3 levels – beginner, intermediate, advanced – and has to place, or delete walls on the given field. After level editing he/she can start to play on the field he/she has just designed. The walls can be placed or deleted by buttons. When using the mouse, the player can develop fine movements of the hands and fingers, while by using Kinect shoulder and arm movements can be practiced.

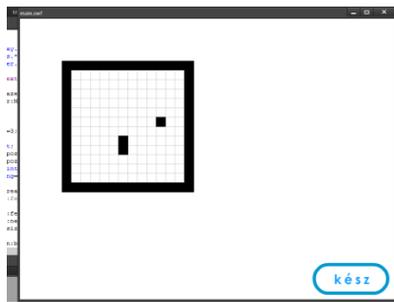


Figure 1. Level editor's graphical user interface.

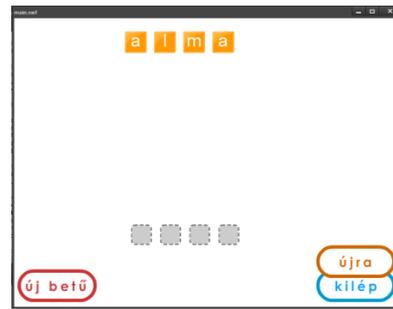


Figure 2. Word-completion game's user interface.

3.5 Word game

The user can start the given number of letters at the top of the screen one-by-one as they press the button. The slider at the bottom of the screen can be moved horizontally. The player has to catch the falling letters with the slider. If the player cannot catch the letter, it will not disappear, but will automatically start to fall from the top of the screen, till it is not stored between the caught letters (as the letter touches one of the empty fields of the slider). If the player catches the letter with the wrong field he/she can restart the game and all of the letters will appear shuffled on the top of the screen. The player can start the letters by buttons. To control the slider: in case of using a mouse the player has to move the mouse sideways, in case of Kinect the arm should be moved sideways to catch the falling letters.

4. CONCLUSIONS

During the research period preceding the development, several new results, methods and devices had been found, which have not been used in rehabilitation. During the research period the authors tried to learn as much about the illness, the course of the disease, the damages that remain after the disease, the rehabilitation processes and their advantages and disadvantages, as it is possible.

By using the national and international literature during the development the aim was to find out most of the information about the methods and try to use them in the game. One of the criteria in the design of the game was to apply the methods collectively. The basis for the development were the specific movements of Wolf Motor Function Test. Although many types of the WMFT test have been analysed, some of its versions have more tasks, some of them less. After comparison, the WMFT test containing 17 tasks had been chosen.

The complete program was tested by healthy subjects and stroke patients in their home environment. The test were completed by subjects from the age of 7 to 60. The feedback was positive, the subjects found the game manageable and enjoyable. Since the program was designed for rehabilitation purpose, there is a great need to test the game with stroke patients in clinical environment. If there is a need for any kind of modifications, these need to be implemented in the program, thus supporting the home rehabilitation of patients.

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