Assignment 1

HCC 729

“The effectiveness of rehabilitation games in stroke therapy”

Samyukta Ganesan

samyu1@umbc.edu
The effectiveness of rehabilitation games in stroke therapy

Introduction

This paper discusses the use of rehabilitation games in stroke therapy. Stroke patients have various impaired mobility, and the using rehabilitation games as a therapy for such patients is a recent area of research. In traditional therapy, the patient is given a set of motor exercises which he/she is expected to do routinely. Exercising everyday over a long period of time is known to improve motor abilities among stroke patients [8]. In this paper, we will explore the technologies that are used for the rehabilitation of stroke patients and look at how effectively they could be used. The research question that this paper addresses is, ‘How effective is the use of rehabilitation games in stroke therapy?’

Background

A huge number of people in industrialized nations are affected by stroke [1]. Most of these people have some or the other form of motor disability ranging from simple constricted finger movements to full body paralysis. Stroke is considered to be one of the main causes of motor disability [1]. It takes a lot of time for a stroke patient to recover completely from any sort of paralysis or motor disability. Many people do not achieve complete recovery even after undergoing stringent out-patient therapy for months. Following the out-patient therapy, they are also expected to do sets of therapist approved exercises regularly. Unfortunately, it has been observed that patients lack the motivation and the desire to do those exercises [1, 2]. This in turn can be seen as one of the causes for incomplete recovery.

The advent of gaming technologies like Wii has given rise to a whole new era of gaming. Since such technologies use gestures and require the user to do actions as part of input,
these are seen as an ideal way to use this technology as a persuasive technology for doing exercises and encouraging fitness. Other than Wii, some of the other technologies used in rehabilitation games include video games and Virtual Reality systems.

A number of rehabilitation games are used as post-stroke therapy treatments for the stroke affected patients. There are lots of challenges that are faced while designing games for improving the motor ability of the stroke patients. In this paper, we will see some of the challenges and possible solutions for the same.

**Motivation and Design**

It is observed that doing the same set of movements or actions over a long period of time increases mobility of the stroke patient and thus therapists often give exercises involving repetitive motor movements [1]. However, the patient is not always motivated enough to do those exercises regularly to regain motor ability.

Hence, one of the immediate areas where attention needs to be paid is - patient motivation. The advent of rehabilitation games acts as the first step towards increased motivation [5]. With the rehabilitation games being used in therapy, the set of daily therapy exercises is now comparable to playing a game. However, this too isn’t sufficient. When games are designed for therapy, it is required by the user to do a set of repetitive actions. Even though the user is playing, the set of repetitive actions could easily get boring [8]. Hence, some focus needs to be paid on the game design itself [5].

Balaam et al. in their paper [7] demonstrate the design procedure that is required for designing rehabilitation games for the stroke patient. They explain the process of user requirements gathering and prototype testing. This is the procedure behind designing a game for a single user. Extending this to multiple users with multiple needs and requirements would be a greater task at hand.
In normal game design, the focus is just on the user and one might just have to concentrate on making the game challenging and entertaining. However, with rehabilitation games the therapist also plays an important role in the design process and is responsible for deciding the kind of motor movements that are required by the patient to perform. The game designer now needs to work on a constrained set of pre-conditions i.e. user inputs. Entertainment is no longer the primary objective, but therapy is. However, one can’t just focus on the therapy without focusing on entertainment because if the users are not entertained they might not be motivated enough to play.

Burke et al. in their paper [8] highlight the two main design areas that one should focus on while designing for good rehabilitation games: meaningful play and challenge. These are derived from normal game design and are not pertinent to the rehabilitation games in particular. The users should see a purpose in playing the game, i.e. the game should make some sense. A challenge could be set by varying the difficulty of the game play. They also test the effectiveness of the rehabilitation games that they designed using various technologies like Virtual Reality, Webcams and Wii.

Other than the self-motivation to play a game, the rehabilitation games can encourage the user by making the game challenging for the user, giving feedback of performance on the current game, maintaining scores and making it visible to the user, analysis of improvement shown over time, etc. [6]

Also, if scoring is used one needs to ensure that the score is seen on the screen so that the user can see it, which in turn can improve motivation during the game [8]. This kind of feedback on performance gives a positive effect and may improve patient motivation.
Calibration

Technologies such as Wii, Kinect and Virtual Reality Environments that require users to physically do some actions for input have given rise to these technologies being used as an exercise tool for the elderly as well as people with motor disabilities. These technologies do not require keyboard or mouse for input, but use hardware such as webcam, accelerometer, balance board and other such devices to track movements. Hence, calibration or mapping plays an important role for these games.

It is important to know how much an individual with motor disability can move their arms or legs. Each person would have different abilities and various levels and ranges of movement. To make the game challenging and motivating it is important to initially calibrate each individual’s range and then set an appropriate difficulty level.

In paper [6], the authors propose a calibration technique in which the therapists can enter values for distances or ranges of the patient for different parts of the body for the initial calibration. Once the actual dimensions of the patient are fed in the system, another screen enables the therapist to enter values in percentages for the range of the patient in order to set the difficulty.

In their paper [3], Geurts et al. discuss four mini-games called Catching Dishes, Collecting Eggs, Preparing Recipes, and Flying Dragons. These games focus on the mobility of different parts of the body like arms, thighs, head, etc. and different calibration and mapping techniques have been used for each of these games. Wii gives flexibility to the therapist to set different levels of difficulty. One of the ways this could be done is by reducing the speed in which the actions for the game needs to be performed which gives the user more time to do the action. Also, the Wii remote can be attached to various parts of the body like the arms and thighs to achieve better and more accurate mapping.
In the games discussed in paper [3], a therapist is required to do the calibration and set difficulty levels which make these games inappropriate for in-patient therapy or therapy without the presence of a therapist. Also, there needs to be a mechanism wherein the user needs to do an initial re-calibration so that any improvement over time is recorded and appropriate difficulty levels are set. Though the paper [3] talks about calibrating in general, it is not stated how often this is done (whether everyday or just once initially), or how often it needs to be done.

**In-patient therapy**

As mentioned earlier, apart from the out-patient therapy the patients are also expected to undergo in-patient therapy. In in-patient therapy, the therapist defines a set of exercises as per the impairment of the patient. These set of exercises are to be done by the patient regularly as suggested by the therapist but however, due to lack of motivation they do not do the exercises regularly.

With the advent of gaming technologies like Wii and Kinect, therapists can now set exercise routines to patients for in-patient therapies and also track the improvements, if any. In their paper [4], Bagalkot et al. talk about using these games collaboratively with the patient and the therapist. The therapist can set exercise routines remotely from the hospital and the feedback of the session done by the patient can be sent back to the therapist. This gives therapist an entire log of activities and a better idea about the patient’s specific requirements, if any.

Such collaboration between the patient and the therapist facilitates in-patient therapy for the stroke patient and thus reduces cost for all [4]. However, for such therapies, games that do not require the therapist’s presence for calibration need to be designed.

Also, it is important that the game be simple enough for the patients to be able to start and install without much dependence on anyone which would in turn give them a sense of
independence. However, if one is using Wii remotes and if they need to be attached to some part of their body, they would require some sort of assistance with the same. But it is important is to limit the assistance that would be required to a minimum and not induce situations wherein the patient would require more assistance in using the technology which would just lead to increased dependence on someone else.

The game should be simple to play, easy to start and install, yet effective in the therapy. If the game leads to the user dealing with technological problems which cannot be solved by the patient without the help of an individual having some technological knowledge, it would severely limit the number of people who could use this kind of rehabilitation games for therapy.

**Conclusion**

Though some benefits are seen in using this technology for a short duration, the research till date does not cover long term effects and benefits of using technology as rehabilitation games for stroke therapy. As far as this literature review goes, there hasn’t been any paper analyzing the long term benefits of using this technology. This could be because this research area is fairly new, and gathering any results of long term usage of this technique would take some time.

Most of the research deals with the development of a prototype and doing a usability test of the prototype. These researches mainly focus on the design of a rehabilitation game that could be used by the stroke patients. Implementation of the actual system and putting it to use would reveal better results. None of the papers provide much of statistical evidence of the effectiveness of these systems. Thus, the effectiveness of using rehabilitation games in therapy is not quantified. One cannot say if the improvements that are seen in an individual using this technology in therapy are due to the exercises themselves, the motivation to do the exercises or rather play the game, or a psychological effect.
There are no papers comparing the effectiveness of using this technology as compared to the traditional therapy. There are no comparisons of the improvements observed on a person using rehabilitation games in therapy with the improvements observed on a person using the traditional therapy.

**Future Research**

By looking at the research till date, one can conclude on a number of research areas that one can concentrate in, in the future.

To start with, there are a number of papers dealing with motivation. However, since all the research has been conducted on a short duration, one might have to evaluate as to how long does the motivation persist? The user might get bored playing the same game after a while and one might have to give them some new game to keep the motivation going.

Intelligent Games that auto-calibrate and change difficulty levels over time would be of great help. There could be a system that can gather data of all the patients, the games they have played and the improvements seen in them. Some kind of patient profiling could be done which could be shared with the therapists to enable them decide on a future therapy technique. It can also help therapists in suggesting exercise routines looking at the patient history and performance. This data could also be used to suggest exercises for other patients who might fall into similar groups. Also, the therapists could select a pre-set of exercises which are given to the patient upon improvement automatically.

Research to compare the long term benefits of using rehabilitation games over traditional therapy techniques could give a better idea on the strengths and weaknesses of using rehabilitation games in therapy.
Future research could focus more of the rehabilitation games for therapies for body parts other than the arms and shoulder movement, since a majority of current research focus on these. More games could be developed for motor immobility in the legs or neck.

To conclude, the effectiveness of rehabilitation games are not quantified. They are believed to improve patient motivation to participate in the therapy and do the exercises more willingly. But a thorough analysis of the long term benefits of using rehabilitation games in therapy need to be conducted.

References


