

Usability Test of a Virtual Reality System Focused on Elderly People with Postural Instability

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Published: 30 November 2022

Abstract

In this work, a usability analysis will be conducted to a virtual reality system which will be used as an aid in the physical therapy treatment of patients who live with postural instability caused by their age. The system must present some design features to allow for easy interaction and understanding of the activities to increase the likelihood of reaching the physical therapy objectives. During the evaluation, 37 heuristics focused on virtual immersion environments will be used, and some playability tests paired with post-test interviews will be conducted. The goal is to design a system that will help reduce the possible negative effects that are normally associated with the use of virtual reality since they can cause physical discomfort or reduce the efficacy of the treatment that patients must follow. In this document, the case study, the testing method, and the design of the tools used for the tests are presented.

Keywords:

Usability; Postural Instability; Heuristic Evaluation; Physical Therapy; Virtual Reality (VR).

1 Introduction

Since the appearance of new technologies, their use becoming more widespread and their incursion in many different fields, people with a great variety of backgrounds have a wide range of tools and solutions easily available to them to help them solve all kinds of problems. Unfortunately, there are still large population groups who are not aware of the new technologies or the correct way of using them, this is why it's the duty of engineers and designers to put their work to the test through usability testing methods to help them find areas to improve their creations.

According to the Hiberus website (*Test de usabilidad: qué es y por qué hacerlo*, 2021, May 19) a usability test is the set of tests and methods that are conducted on a website or applications with

the goal of prove the commodity, ease or complexity with which it can be used [5].

Usability tests, like the Heuristic analysis, are used mainly in 2D environments, this means that most are used to evaluate mobile applications, web pages, desktop applications environments in which most users already have access, but for virtual environments, it's a somewhat new little studied area since it involved a larger number of the users' senses.

Nowadays there is a great number of technological tools which cause a great impact on humanity, but most are focused on people who already have previous knowledge or has already been introduced to them. A clear example of users who normally have problems using new technologies are the elderly who struggle with technology since they're not too close to them which makes them reluctant to try new things and face technological challenges [3,1], their education level can also be a factor in them wanting to try new things or not. This project arose because of the high level of abandonment observed by therapists during the physical therapy processes of older people who live with postural instability due to their age, the end goal of this system is that through the use of ludic activities, their engagement can be increased while at the same time helping increase the completion index of the physical therapy process.

Simultaneously with this research, the creation of a VR system is underway, its focus is to help the physical therapy process for older adults who live with postural instability due to their age [2,6]. In the beginning, this system wasn't built following a user-centered approach, so at the moment the team building it wants to identify areas where the user experience can be improved while also helping improve the physical therapy process, based on the results from this evaluations, the tool will be adapted to make it more usable for the end users.

2 Heuristic evaluation

Even though virtual reality is not a particularly new technology, its use by elderly people is not frequent, in order to make the system usable in an intuitive and friendly way by people with no experience with VR a good user experience needs to be implemented.

For this study, 37 heuristics [11] applicable to VR based on [8] will be used in an evaluation with experts, this way, possible shortcomings of the VR system can be found before it is used by the end users. Evaluations will be conducted through observations of both physical therapy and engineering experts, while they are interacting with the virtual environment, this way issues that can make it difficult to use the system, because of patients' physical

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condition or because of the design of the elements inside the environment, can be found ahead of time.

Additionally, an interaction design [9,10] will be done, with this the VR tool will be adapted to take into account the actions that patients normally do and adapt them into the system when they're needed.

Analysis of test results is expected to provide insights that help make suggestions for features that can improve the end-user experience.

3 Case study

The heuristic evaluation of virtual environments will be carried out using a set of tests focused in measuring the usability of 4 mini-games and a selection menu, these mini-games are an extract of a system that will be used as an aid in physical therapy for elderly people who live with postural instability caused by their old age.

The users are placed in the starting position, which is in the center of the play area, and they sit on a chair, from there they can perform some of the minigames. The first scene that users will be presented with is that of the selection menu. In this scene, they will see previews of each one of the mini-games, and the user will have to choose one to be able to begin the activity.

Mini-game 1. It consists of the users being seated and through the movement of the upper body, they need to avoid paper airplanes that are flying toward them. Some possible problems that can arise are that the users could move too fast, which might lead to them feeling dizzy or even falling from their chairs, one more issue can be that the airplanes might be difficult to distinguish (see Figure 1).



Figure 1. Mini-game 1 – Avoid airplanes.

Mini-game 2. From a seated position, the users will have to pick vegetables from the ground and place them in the corresponding box for each type of vegetable, these boxes are placed on a table in front of the users. Some issues that may arise are that users might not find the vegetables since they appear in different places, nor being able to reach the objects, this could also bring a risk of dizziness or falling since users will have to try and reach object which are farther than what they're used to (see Figure 2)



Figure 2. Mini-game 2 – Reap harvest

Mini-game 3. From a standing position, the users help a sheep jump moving logs that are speeding toward it, to do this, the users will have to lift their heels (stand on their tiptoes) for the sheep to jump and avoid the logs. Some problems that may arise with this mini-game are the risk of falling since the users need to stand on their tiptoes and the logs' speed is too fast, rushing the users (see Figure 3).



Figure 3. Mini-game 3 – Jump obstacles.

Mini-game 4. The users will have to cut fruit from trees while in a seated position, then place them in its corresponding bowl on the table that is in front of them. Some problems that may arise are that they can't find the fruits since they are above their head, at the same time they could fall while stretching to pick the fruit and place them on the table (see Figure 4).



Figure 4. Mini-game 4 -Cut fruits

4 Method

The proposed heuristic evaluation is expected to be carried on in two sections, the first will be done with physical therapists from the Autonomous University of Manizales in Colombia (UAM) and the second by engineers from the VR group of the Technological Institute of Higher Studies of Zamora (ITESZ) in Mexico.

In order to keep the end users (elderly people who are 65 years of age or above) in good health and avoid putting them at risk, due to factors like COVID-19 infection (they have to share the VR Headset with other people) or risk of a fall, it was decided to involve physical therapists during these initial tests since they know the abilities and difficulties of said users while performing the activities using traditional physical therapy.

The present work's progress level covers the activities described in the contextualizing section and preparation. The development stage is currently being conducted, however, it's being described along with subsequent stages to allow for the overall understanding of the work in progress.

4.1 Contextualization

The first step was to interview 5 physical therapists, 2 from the UAM and 3 who work in Zamora, Michoacan in Mexico, with the

goal of getting a better understanding of the target users' overall physical condition during their recovery processes, their reactions during therapy, discomforts [4] and some general recommendations were gathered regarding a VR system since it could be used by them as an aid during physical therapy.

From those interviews, information gathered includes

- Patients might have diverse physical conditions which might complicate their use of VR technologies in their therapy, these might include reduced vision, hearing or both, limited mobility or flexibility amongst other things.
- During their traditional therapies, patients present discomforts like muscle pains, fatigue, dizziness, high or low blood pressure, decompensation for not taking their medications as indicated by their doctors, etc.
- Patients in general are open to trying technologies presented to them in order to improve their processes, however, in the experience of the physical therapy interviewees, around 35% of patients are reluctant to try highly technified approaches.
- Patients who are reluctant to new technologies generally come from rural areas or have a low school education.
- Physical therapists are willing to implement VR technologies as an aid in the physical therapy processes they conduct.

4.2 Preparation

During this stage, the documents that will be used either, before, during, or after the tests, were created, some of which were:

- Requirements page
- Requirements validation form
- Information sheet
- Consent form
- Schedule
- Controller explanation page
- Tasks list
- Naming sheet
- List of heuristics
- Severity rating
- Filling format

4.3 Test development

During this stage, participants will be summoned, each at a different schedule. Each session will be recorded, from their arrival until the moment they leave, this will be done with the intention of the complete user experience. Each session will last between 45 and 60 minutes per participant. Each will be handed an information sheet for them to read and let the team know their questions, in case they decide to move forward with the test, they will be handed a consent form for them to sign, and later on, they will be shown the equipment which they will be using for the evaluations, starting with the controllers, followed by the VR Headset, once they're comfortable with it, they will be placed in the center of the test zone. Once they're in the center of the testing zone, the VR system will be powered on and they will be guided through the first scene to help them gradually adapt to the virtual environment before starting with the tests.

Once the VR system has started, the tasks will be dictated to the user by the person in charge of the tests so that they can complete them in each of the mini-games, in turn, the user will have to describe aloud the experiences, what they are seeing, listening and the sensations they have during the performance of the tasks,

and they will be asked to try to provide as much detail in their description as possible, in this way the difficulties that may arise during the tests could be identified.

After the mini-game activities are complete, the VR gear will be removed and users will be surveyed to provide details they observed from their personal perspective.

4.4 Evaluation

Once the development stage is done, the heuristic evaluation will take place. First, they will be given the heuristics to be used, as well as the severity ratings [7] that will be used, they are coded with numerical values as follows:

- **0 = Not a usability problem:** in this person's opinion, the item under discussion is not a usability problem.
- **1 = cosmetic problem,** users will be mildly frustrated, need not be fixed unless extra time is available on the project.
- **2 = minor problem,** users will be frustrated/have some difficulty continuing to their goal, fixing this should be given low priority.
- **3 = major problem,** users will be very frustrated/have difficulty continuing to their goal, important to fix, so should be given high priority.
- **4 = catastrophic problem,** users will not be able to continue to their goal, imperative to fix this before the product can be released.

In addition, they will be provided with a filling format where the description of the problem found, the heuristic to which it refers and the degree of severity that applies to the said problem will be noted, as shown in Table 1. This task will be repeated with each of the experts.

Table 1. Example of filling for the evaluator

Game num.	Description	Relevant heuristic	Severity rating
1	Light is very bright when an object is selected.	H1...	1
2	Difficulty picking up objects.	H2...	2

4.5 Analysis and Expected Results

In this stage, all the information collected in the heuristic evaluation will be analyzed, as well as what was observed in the tests of each of the participants. After this analysis, it is expected to obtain information to generate a set of recommendations for improving the design of the VR system in order to make it more intuitive and friendly, and thus favor the end users (elderly adults).

Finally, it's expected to identify the most important heuristics that need to be taken into account when developing immersive virtual environments aimed at older adults, especially for those who suffer from postural instability due to age, the main target group of this study.

5 Future work

The next steps to be taken into account are the gathering of all the information generated through the heuristic evaluations done by both physical therapy and engineering participants, as well as analyzing it.

Subsequently, after identifying the most significant heuristics and the main improvement points for the system, redesign recommendations will be made to the development team and new tests will be carried out to determine if the problems were solved or if they persist.

Finally, tests will be carried out with older adults, it is expected that the problems identified by the experts will be mitigated and that the end users can complete their physical therapy processes with the best possible experience.

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