

Games and Exercises Applied to Rehabilitation Adaptable Environments for Mobility of Elderly People and/or People With Low Mobility

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Abstract— There are several approaches in the area of rehabilitation that invoke technology for a more comprehensive and dynamic learning process aimed at the physical and psychological recovery of a disabled person, with a view to their reintegration and possible recovery. The existence of collaborative tools used to support the rehabilitation by using communication and cooperation between patients, family and therapists on knowledge sharing and collaborative knowledge building has been the subject of studies. The research topic "Exercises and Serious Games Applied to Rehabilitation" arises from the concern to understand and adapt the use of technologies for rehabilitation, and so the present work proposal aims to conduct an information collection to identify potential factors in order to adapt the technological tools to the patient's rehabilitation process. To support research we intend to analyse and work only with a specific area of rehabilitation, the physical part with a focus on body members to rehabilitate. The research involves understanding the different processes of rehabilitation and efficiency rates. It proposes to address a new methodology within the educational and rehabilitation programs that have not received the attention of current researches, and aims to relate the patient rehabilitation process with existing technological means and to investigate how this relationship can contribute to a more effective solution in the rehabilitation process. This study will be developed in the research I&D group GILT (Games, Interaction and Learning Technologies at ISEP (Superior Institute of Engineering of Porto) and in cooperation with institutions working in the area of rehabilitation, in order to obtain information and different points of view. The end result is expected to propose methodologies and to develop a platform with a set of exercises and serious games facilitators of the rehabilitation process the body members.

Index Terms— Adaptable Environments, Interaction Devices, Rehabilitation, Serious Games

1 INTRODUCTION

Throughout life, we find that people are losing some of their ability to perform movements. This usually is worsening at the end of life, noting that the lack of ability to perform simple movements can pose for the persons concerned, a significant loss of quality of life and consequently an increase in dependence on third parties.

The rehabilitation process aims to help people recover their movements (and in some cases their mobility) in order to assist them to adapt to their new living conditions. The main objective of the physical rehabilitation process is to help people an adapt to their new condition of life.

The current research work presents the use of different activities and exercises in a resources system and proposes to develop new methodologies and tools training, recovery or maintenance to support the rehabilitation of persons, or groups of persons, integrated a learning and rehabilitation platform that spans multiple degrees of disability having origin in different pathologies.

The applications to be developed in this project will be in training mode (maintenance), rehabilitation training (recovery), as an instrument to support the patients in their recovery and allowing them to self-assess their evolution with the data acquired during the entire process. A possible competitive game mode is not provided at an early stage, because it will only be available at a later stage and only for some pathologies after further analysis.

One of the aspects that make up this project is the ability to capture the area's body movements needing rehabilitation by real-time reporting of the necessary corrections and by transmitting relevant information in the patient rehabilitation process.

This information is useful for the patient in order to support his therapy and evolution, and may be a contribution to the therapist's analysis and for possible adjustments in treatment. This work involves participants (patients and therapists) with various pathologies and from different institutions according to the established contacts and collaborations.

2 THE PROBLEM

The ability to perform movements is extremely important for people as it is through it that can make their daily tasks, many of them essential to your personal well being. It appears however, that over the years, human beings tend to lose some of their motor skills that can prove to be just one of the members or affect more than one, including the lower limbs that may affect the mobility of these people.

A serious games environment applied to rehabilitation is related to various areas of knowledge. The health professional identifies the pathology and the rehabilitation technician follows the patient's evolution process. The performing of tasks must meet certain criteria in order to achieve the tasks' proposed objectives.

The patient is able to work on his rehabilitation through new processes that are more motivating and less emotionally fatiguing. However, these patients have to travel constantly and routinely to the rehabilitation center in order to carry out their defined program in the rehabilitation process.

The area of interest of this research is to find a methodology to assist in the rehabilitation therapy, one adaptable to the patients and allowing them greater independence and motiva-

tion to carry on with the process, by way of a solution that allows them to perform the therapy by reducing the number of trips to the rehabilitation center, or even, for example, by carrying out the rehabilitation in the comfort of their home environment.

According to patient needs, the system allows adapting the methodology to the patient and provides a support tool to complement the work of the rehabilitation technician. Health professionals have thus at their disposal a system that avoids the constant need of their presence during the exercises set for the rehabilitation process, in specific cases where patients are under proper supervision.

This work intends to develop a methodology for that therapy, and so its main objectives consist of defining the necessary criteria for the optimization of serious games tailored to patients and therapy, as well identifying and collecting data from the patients and health professionals' experience or knowledge. The aim is to implement a system to assist in the rehabilitation process environment for the purpose it is intended, and also to validate the methodology and the system through an experimental group of patients in a rehabilitation center environment and in their proximity.

The proposed work is to develop a system with adaptable environment for older people who allow their rehabilitation mobility using the platform to make training of the lower limbs and relearning of movement. Encompasses both the platform construction as the need for hardware to read movements as well as the study of development methodologies, techniques and algorithms for serious games with special emphasis on the implementation of the rehabilitation of the mobility of elderly and/or people low mobility.

2.1 Hypothesis and Research Questions

The previous researches try to see the use of serious games in rehabilitation, particularly in looking for characteristic factors inherent to a system and to patients, such as advance of preparation, context, motivation, success, among others.

Although there is no complete validate definition on what would be a significant set of characteristic factors, there is a considerable number of investigations in this area.

In line with said previously, the hypothesis of this search method is a technology platform that aims to be a methodology used as the reference element.

From the analyses carried out so far arise the research questions, as summarized below, from the perspective of a serious game approach to rehabilitation:

How can serious games and exercises be used to contribute to the specific rehabilitation process?

- Which are the basic characteristics in serious games for purposes of rehabilitation?

Is the choice of factors able to explain a patient's progression?

Which features can be integrated on a platform to provide a methodology for evaluating a serious games system in rehabilitation?

How to develop strategies for the success of a methodology integrated on a platform?

How can engage in a serious game physical and knowledge recovery?

How can a serious game be adaptive and personalized to a patient?

2.2 The Rehabilitation Process

Historically, the term rehabilitation has described a range of responses to disability, from interventions to improve body function to more comprehensive measures designed to promote inclusion.

However, as shown on the below picture, rehabilitation is a complex area and involves many different approaches as brain, training, occupation and physical as many others.

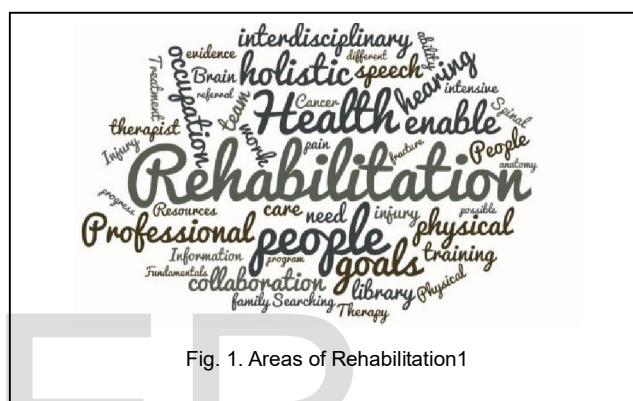


Fig. 1. Areas of Rehabilitation¹

For some people with disabilities, rehabilitation is essential to being able to participate in education, the labour market, and civic life.

Rehabilitation is always voluntary, and some individuals may require support with decision-making about rehabilitation choices. In all cases rehabilitation should help to empower a person with a disability and his or her family. [1]

Rehabilitation is "a set of measures that assist individuals who experience, or are likely to experience, disability to achieve and maintain optimal functioning in interaction with their environments". A distinction is sometimes made between habilitation, which aims to help those who acquired disabilities congenitally or early in life to develop maximal functioning; and rehabilitation, where those who have experienced a loss in function are assisted to regain maximal functioning. [2]

Rehabilitation reduces the impact of a broad range of health conditions. Typically rehabilitation occurs for a specific period of time, but can involve single or multiple interventions delivered by an individual or a team of rehabilitation workers, and can be needed from the acute or initial phase immediately following recognition of a health condition through to post-acute and maintenance phases.

Rehabilitation involves identification of a person's problems and needs, relating the problems to relevant factors of the person and the environment, defining rehabilitation goals, planning and implementing the measures, and assessing the effects.

The rehabilitation provided along a continuum of care

¹Image available on <http://s3.amazonaws.com/libapps/accounts/46182/images/wordcloud.jpg>

ranging from hospital care to rehabilitation in the community [3] - can improve health outcomes, reduce costs by shortening hospital stays [4], reduce disability, and improve quality of life [5].

Rehabilitation is cross-sectoral and may be carried out by health professionals in conjunction with specialists the other fields, in line to modified version of the rehabilitation cycle in fig. 1 [6].

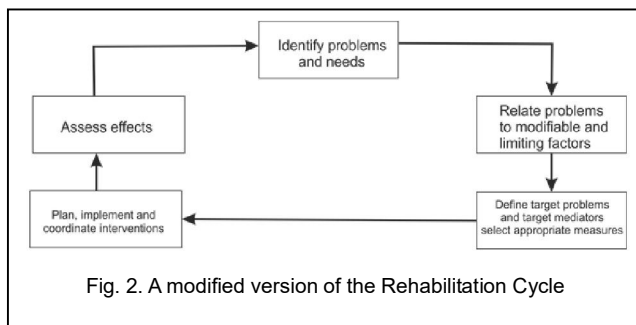


Fig. 2. A modified version of the Rehabilitation Cycle

2.3 Assistive Technologies in the Rehabilitation Process

An assistive technology device can be defined as “any item, piece of equipment, or product, whether it is acquired commercially, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities” [7].

Assistive technologies, when appropriate to the user and the user’s environment, have been shown to be powerful tools to increase independence and improve participation [8].

For people in the United Kingdom with disabilities resulting from brain injuries, technologies such as personal digital assistants, and simpler technologies such as wall charts, were closely associated with independence [9]. In a study of Nigerians with hearing impairments, provision of a hearing aid was associated with improved function, participation and user satisfaction [10].

Assistive devices have also been reported to reduce disability and may substitute or supplement support services – possibly reducing care costs [11]. In the United States of America, a study showed that users of assistive technologies such as mobility aids and equipment for personal care reported less need for support services [12].

Serious games can be used in various fields such as education, medicine, the business environment and the military community. It should be noted that one cannot apply any given game for rehabilitation purposes. As noted in [13], there are games, generally called “common games”, that could be interesting for patients, but they present a small therapeutic potential because they generally require rapid responses from the users, or even more complex movements than those that the patient can perform at that moment, thus making their use impracticable. It is therefore necessary to adapt the game to the limitations of the patient [14]. In [15] is expressed the need to customize the experience of the treatment and to make the game highly adaptable, either by means of algorithms that will adapt the game during the session or by the use of predeter-

mined settings defined by the health professional before the session. Although it requires more development time, the real-time adaptive approach with algorithms can provide better results in motivating the patient, for it would be easy to identify his difficulties and modify the game to make it easier to play before it can cause frustration; in the same way, the algorithm could gradually increase the difficulty, for instance, when the game is too easy for the patient, so that he feels challenged and does not get tired of the activity [16].

By using serious games therapy it is possible to provide real-time visual feedback, besides offering a challenge to the patient and strategies that can increase his motivation by giving meaning to the movements being performed [17]. Depending on the necessary equipment, these games can be used by the patient even in the comfort of his own home. But, in order to avoid a complete lack of monitoring by a health professional, serious games can register the patient's performance and/or his movements, making the data available for further medical follow-up [16]. There are several serious games projects, some of them with quite impressive results in the recovery of functionality, while others have not yet had enough time to yield conclusive results, but managed to please the patients [18]. The utility and effectiveness of specific serious games in the medical field is always somewhat unclear. This is due to the lack of evidence on the validity of games, as well as the lack of information available to the public. In addition, the insufficient understanding of the design principles between the game developers and the institutions that use a serious game in the medical field compromises its use [19]. Serious games are digital games designed to improve the user's knowledge, skills or attitudes in the “real” world. Serious games applied to medical or health-related purposes are growing in number and types of applications. Serious games-based interventions have been used to support the rehabilitation of disabled patients, thus proving their efficiency as compared with conventional treatment programs [19].

In terms of effectiveness, although the results for serious games designed for those purposes are promising, their implementation as a form of prevention, treatment, or training in healthcare is hampered by a lack of understanding, or even distrust, of the underlying concepts among health professionals. Before physicians and patients consider using serious games as a useful solution to a rehabilitation-related problem, it is important that they understand the role, effectiveness and reliability of these games in the therapy process [20]. Studies on the validity and effectiveness of serious games remain scarce [21] [22].

3 RESEARCH IMPLICATIONS

The contribution of this research is the study and developing a technological platform and resources for the use of serious games in rehabilitation. Although other research works are dedicated to serious games in rehabilitation, this work presents differences. The system we intend to develop also differs from the majority of the existing systems, for it allows adapting the methodology to the patient according to his specific needs. The system improves the user's rehabilitation condi-

tions.

Another contribution comes from allowing patients to perform the rehabilitation process in more familiar surroundings, under the supervision of health professionals, and so there is no need for patients to travel regularly to rehabilitation centers for therapy. In addition, the health professional that follows the therapy has access to the data, which means that his presence is not required in many exercises involving constant repetition.

The system referred in this work offers new contributions, a platform with multiples resources for adaptable environments for mobility of elderly people and/or people with low mobility that allows communication between patient and therapist, rehabilitation facilitator with data of evolution, different exercise levels.

This study proposal also intends the articulation of design elements in a serious game from a patients centered perspective. Involving patients in the system and methodology design remains an imperative if serious games are to be fit for purpose, rehabilitation.

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