

A Method to Develop Interactive Environments to Support Occupational Therapies

Héctor Cardona Reyes^{1(✉)}, Jaime Muñoz Arteaga¹,
Juan Manuel González-Calleros², and Francisco Acosta Escalante³

¹ Universidad Autónoma de Aguascalientes,
Av. Universidad #940,
20131 Aguascalientes, AGS, Mexico
{k6550g, jmauaa}@gmail.com

² Universidad Autónoma de Puebla,
Av. San Claudio Y 14 Sur,
Puebla, PUE, Mexico
juan.gonzalez@cs.buap.mx

³ Universidad Juárez Autónoma de Tabasco,
Av. Universidad S/N,
86040 Villa Hermosa, TAB, Mexico
francisco.acosta@ujat.mx

Abstract. Physical therapy is not limited to a simple rehabilitation procedure; this paper proposes a method for production of interactive environments in order to support the recovery process for people with temporary physical disability. The proposed method preconizes the rehabilitation as a set of ordered steps, taking into account best practices in occupational therapy coming from several actors involved in the rehabilitation process such as patients and specialists, but also those involved in the production and design of interactive environments. Then the proposed method is composed of models to design different levels of interaction that must be taken into account to produce interactive environments for users with different levels of ability/disability; these environments could represent an accessible mean with low cost and current trend of technology.

Keywords: Interactive environments · Disability · Occupational therapy · Activities of daily living · Rehabilitation and MDA approach

1 Introduction

According to the World Health Organization (WHO), more than one billion people worldwide live with some form of disability [1]. There are various techniques and methods that are part of physical therapy, one of them are the Activities of Daily Living (ADL) [2]. Reed and Sanderson [3] and Romero [4] consider the activities of daily living such as tasks that a person could be able to do to take care of themselves independently, including personal care, communication and movement. In addition, people with physical disabilities requires treatments for better develop their physical

therapy in a way that is useful, affordable, with low cost and available resources that may lead to restoring mobility, freedom and independence. This work proposes a method for production of interactive environments as a solution that meets the specifications of specialists in occupational therapy regulating the process of recovery of people in rehabilitation through activities of daily living and capitalizes good practices presented, and involves various actors involved in the rehabilitation process such as patients and specialists.

2 Related Work

The literature there are several works on rehabilitation, Table 1 shows some works that address the rehabilitation support through the use of technology.

Table 1. Related work that support rehabilitation through virtual environments.

Work	Domain
[6]	Design model
[5]	Interactive system
[8]	Serious games, videogames, virtual reality
[7]	Interface design

However, the related works presented do not provide information on the process of production, if they form a multidisciplinary team for its development, it is also unknown or not available the best practices that can be of support to other patients and specialists. So this work proposes a method for producing interactive environments incorporating the above aspects and could be a solution to regulate the process of recovery of people in rehabilitation.

3 Problem Outline

Define a method for designing interactive environments required deal with the following problems: It lacks of techniques to capitalize on the knowledge provided by experts and documented practices available in rehabilitation issues; It lacks of a user-centered software for solving specific user needs; It is necessary a method to capitalize some best practices and foster rehabilitation for systematic production of interactive environments according to the needs of people with disabilities; There are several multidisciplinary areas and several roles should be take into account, such as specialists, designers, analysts, programmers, and end users in the production process of interactive environments; It is important to consider the adaptability of interactive environments to different user contexts. In the next section the proposed design interactive environments, as a support method is approached rehabilitation.

4 Method to Develop Interactive Environments

This work proposes a method for the development of interactive environments based on a model approach, as shown in Fig. 1. The method starts with the definition of skills based on real situations such activities skill, sensory, problem solving through movements and activities that recreate situations of daily life or work (occupational therapy) [2, 9]. Furthermore it is based on clinical practice guidelines (CPG) [10]; which they are recommendations grounded in the best available evidence in order to contribute to the quality and effectiveness of care.

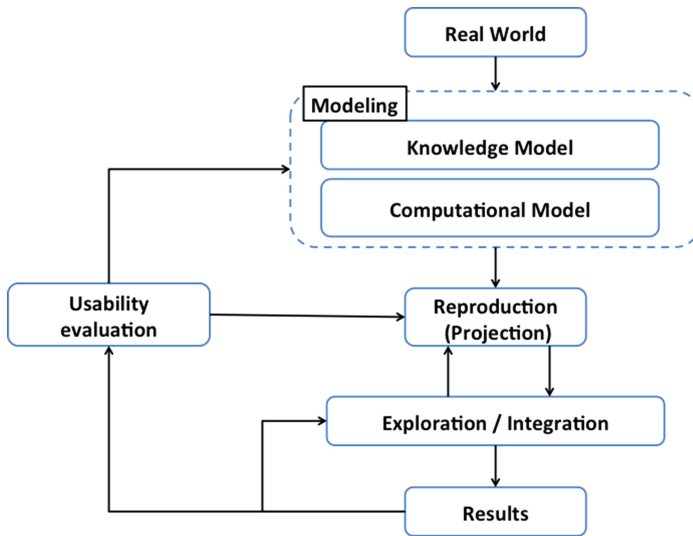


Fig. 1. Method for developing interactive environments to be used for occupational therapies, adapted from [9]

The identification of real world situations can create a representation of the activities that will be necessary to model, i.e. generate a knowledge model to know the user characteristics with disabilities, defining their skills and limitations, this can generate a computational representation of the environment in 2D or 3D considering the user functional limitations identified in the knowledge model. According to the type of occupational activity and user requires a model that captures the requirements and information to permit that can only be used by users with a certain level of functionality. Once established parameters and model entities actions are taken into account substantial information to the specialist and the patient to allow the assessment and classification for feedback will allow to obtain data on the acceptance of the design model inserted into the prototype environment caused and whether or not it is a representation of the user mental model. Next section explains in detail each stages of method throughout a case study about the motor rehabilitation of hand muscles.



5 Case Study

This section discusses the implementation of interactive environments in young adults with disabilities who receive OT for hand rehabilitation in the System for the Integral Development of the State Family Aguascalientes, Mexico (DIF) [11]. The DIF has a Physical Therapy Unit with different modules where there are different devices that facilitate the rehabilitation of patients [15]. This case study had the participation of patients and experts attending the Unit of Physical Therapy, patients here have different conditions in terms of age, disability and type of treatment to follow. On of the purpose to develop this case study was to assist the recovery of patients receiving rehabilitation of the hand through the use of interactive environments besides checking each of the stages performed in the method design for interactive environments proposed.

Real world stage: In this phase a group of five volunteers, aged: 9, 50, 58, 63, 68 years, with diagnoses including surgery sequel, hand dystrophy and primarily cerebrovascular events. Two specialists in physical rehabilitation within a 30-minute session lead treatment for these patients, which is to conduct activities through occupational therapy to regain mobility in her hands. The objective in this stage was to identify the evaluation of the patient’s functionality to provide a definition of the desired patient’s cognitive abilities and know the limitations of potential users.

The modeling stage: The specialist determines a set of movements founded on the documented techniques occupational therapy [12], these movements are divided into two types, movements of the fingers and thumb movements, as shown in Table 2.

Table 2. Some hand movements for occupational therapy [12]

Type of movement	Action to take	Image
Mobility of fingers	With the tip of the thumb, try to touch the yolk of each of the other fingers.	
Thumb opposition	Bring the heel to the base thumb finger, starting and ending index little finger	

This permits us to define a model user tasks and interactions to be simulated within the interactive environment as well as the variables and indicators for expert and patient feedback.

The computational model helps determine the platform, modeling languages and elements taking into account the needs of the user, with it 2D and 3D scene objects for interactive environment are determined. In this sense a diagram of tasks [13] is performed based on knowledge to assign physical hand therapy for this group of patients. As shown in Fig. 2.

Projection stage: The projection allows determining the correspondence according to the presenting problem and target users. Physical therapy specialist involved in the design process validates interactive environment that effectively produced interactive

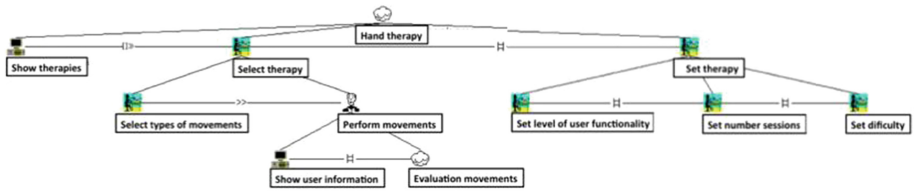


Fig. 2. Specification of therapy for hand rehabilitation in terms of user task.

environment, have the required feedback and is right under the required treatment and occupational therapy activities.

Exploration and Integration stage: During this phase basic instructions are given to patients for use of the interactive environment, the virtual scenarios and 3D objects in the scene are described, as shown in Fig. 3. A session of 20 min on average was established for each patient where performed the tasks set by the interactive environment and the information obtained in this session allow information that goes from the perception of patients to a new way of carrying their recovery through the use of technology to shape how these environments help to assist the rehabilitation process and information for feedback. Interactive environments used allow the rehabilitation specialist and the user have a guide feedback and monitoring of rehabilitation sessions [9].



Fig. 3. Hand rehabilitation through an occupational therapy at DIF in Aguascalientes, Mexico (left), and computer assisted hand rehabilitation (right).

Results stage: The results define new variables that allow feedback model this can ensure as far as possible the appropriate model to assist the rehabilitation process of the user. Which will be of great importance to the feedback process. These results provide feedback to the expert and patient in order to know the current situation in terms of mobility of the hands. It is noteworthy that allowed interactive environments exposed the patient to know new forms of interaction for their rehabilitation session.

Evaluation stage: At the conclusion of the exploration phase, a questionnaire based usability scenarios [14] was applied, in order to measure user satisfaction in relation to the usability of interactive environments. This questionnaire was conducted

through observation, it is important to mention that users with disabilities is not easy to apply a questionnaire, in many cases professional assistance is required, so it is important to define new strategies for usability evaluation for these users.

6 Conclusions

This work highlights the importance of having a model-based method, which allows through its phases, designing interactive environments that are a support for the rehabilitation of people with disabilities [15]. This method considers the established practice used by rehabilitation specialists to carry the context of an interactive environment, and provides feedback to both the patient and the professional therapy. The case study in DIF patients served as a starting point to test the proposed method and follow up on the issues raised. It allowed to obtain results for feedback from experts and patients, in addition to observing a cognitive effect of improved perception of objects in relation to the member in rehab. Finally, the proposed method allows interactive environments adapt to the needs of users and experts, giving users have a support in their rehabilitation process.

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