TeleREHA: Online/Offline Web Platform for Telerehabilitation of Post-stroke Arm Impairment*

Javier Arcas Ruiz-Ruano[1,**], Joel C. Perry[2], Cristina Rodríguez-de-Pablo[2], and Thierry Keller[2]

[1] Assistive Technologies Department of the Health Division of Tecnalia, Zamudio, Spain
javier.arcas@tecnalia.com
[2] Rehabilitation Technologies Department of the Health Division of Tecnalia, Donostia/San Sebastián, Spain
joel.perry@tecnalia.com

Abstract. This document presents a telerehabilitation system for training the upper limbs after stroke. The system uses serious games on a web platform and an electro-mechanical device called ArmAssist which acts as a tool to support arm reach movements and provide the control input for the rehabilitation games. We describe two versions of the system: one is adapted to be used at facilities where no network connection is available; the other one can be used remotely through the Internet, with patients at home carrying out their rehabilitation games, and with therapists at their workplace supervising and assessing patients' evolution over a period of time. The document also describes preliminary feedback results of usability testing at two rehabilitation facilities.

1 Introduction

The deployment of telerehabilitation technologies at home have remained limited despite increased interest and research in the last decades. Along these lines, a new integrated solution for upper-limb telerehabilitation of post-stroke patients has been developed. The system is composed of a web platform, an input device such as the ArmAssist [1], and serious games for assessment and training [2].

Two types of platforms have been created. The first one, called "TeleREHA online", provides patients the ability to do rehabilitation training at home, making use of the Internet connection, while therapists in the clinical setting are able to assign therapies, assess results, and follow the rehabilitation games remotely in real time. The option of peer to peer communication using audio and video is also available. All data is stored in a centralized server where the web application is running.

* This work has been funded in part by FIK and the Spanish Ministry of Science (Project PID-020100-2009-21).
** Corresponding author.

J.L. Pons et al. (Eds.): *Converging Clinical & Engi. Research on NR*, BIOSYSROB 1, pp. 991–995.
DOI: 10.1007/978-3-642-34546-3_162 © Springer-Verlag Berlin Heidelberg 2013

The second platform is called “TeleREHA offline”, and is intended to be used at facilities where no Internet connection is available, a frequent occurrence in walled interior rooms or basements of large medical centers, and also as a result of many hospitals’ IT security policies. In such cases, the offline version allows the continuation of training without location limitations. This is a reduced version of the online platform, providing therapists the ability to manage patients, assign therapies and transfer results to the centralized server through a temporary internet connection or through a manual file transfer process.

The “TeleREHA offline” system, described in [1], consists of an all-in-one PC with a 21" touchscreen, the ArmAssist, and a special mat to translate the ArmAssist global coordinates on the plane to spatial coordinates inside the game environment. Two hospitals are involved in the evaluation of the clinical usability of the system.

2 Online and Offline Platforms

2.1 Platform Features

The final software support features for patients and therapists for the “TeleREHA online” and “TeleREHA offline” versions are outlined in Table 1.

Table 1 Telerehabilitation system features

User	Zone	Feature Description	On-line	Off-line
Therapist	Patient Management	Create/Edit/Delete patients	X	X
		Manage therapies calendar / assign rehabilitation games	X	X
		Access game results and patient evolution	X	
		Real time remote monitoring of patient	X	
	Commu-nication	Videoconference with patients (one at a	X	
		Videomessaging system between therapists and patients	X	
Patient	Therapy	Access daily rehabilitation games	X	X
		Access game results and “best scores” per game	X	
		Weekly calendar with pending therapies	X	
	Commu-nication	Videomessaging system between patient and therapist	X	

In the “online” version, the therapist side supports all aspects of patient management, and the patient side supports all aspects of therapy performance, while both therapists and patients have some access to modes of video communication. In the “offline” version, however, only the essential features are maintained, such as editing patients and managing therapies for the therapist, and

accessing training games for the patient. All rehabilitation results obtained by patients are stored locally in XML files.

In addition to the reduced set of functionality in the "offline" version, the therapist-side layout was also redesigned for faster and easier use, reducing the elapsed time between therapy assignment and patient training.

Fig. 1 Assigning therapies on the TeleREHA online (top) and offline (bottom) platforms

As the "offline" system does not provide a graphical visualization interface for the results display, the result files must be transferred to the centralized server, so rehabilitation data can be accessed later using the online version. The "TeleREHA offline" platform is provided with a data transfer module linked with the server, only available when the all-in-one PC has an Internet connection. There is also a manual transfer process, where the result files can be copied to a USB stick and transferred later to the server using a connected PC. A view of the patient evolution can be seen in Figure 2. All data stored in the centralized server observes the Spanish Privacy Act.

2.2 Platform Development

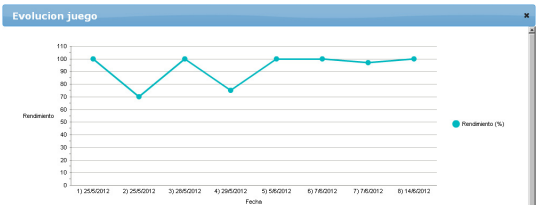
1) TeleREHA online – Java is used as the primary language for the system server development, with Tomcat 6 as the application server. The Spring framework is used in a 3-layer model, including Hibernate with MySQL as the database layer, and Primefaces for the presentation layer. The red5 media server is used for video communications.

2) TeleREHA offline – A 2-layer model using Java Server Pages and XML as repository is used, avoiding the installation of a local database. The application server is Tomcat 6.0. Ajax is used for results synchronization with the centralized server.

3) *Games* – The same technology is used in TeleREHA online and offline. 2D games, described in [2], are developed with Java 2D. 3D games are built with Java Monkey Engine 2. Games are deployed on the web browser using Java Web Start. Game results are stored in XML files and then transferred to the centralized server accordingly.

2.3 Usability Testing

The complete telerehabilitation system described above was developed and is undergoing testing with therapists and patients in both in-clinic and at-home settings at two different centers, Hospital La Fe in Valencia, and the Guttmann Institute in Barcelona. Due to a lack of network infrastructure because of internal security regulations, both centers were provided with the TeleREHA offline system.



Exportar datos como: EXCEL PDF

Rendimiento

Fecha	Hora de inicio	Duracion	Estado	Nivel	Rendimiento
25/5/2012	10:26	29 segundos	Terminada	Nivel 1	100
25/5/2012	10:52	1 minuto, 52 segundos	Terminada	Nivel 1	70
28/5/2012	10:22	17 segundos	Terminada	Nivel 2	100
29/5/2012	9:15	46 segundos	Terminada	Nivel 2	75
5/6/2012	9:42	28 segundos	Terminada	Nivel 2	100
7/6/2012	9:49	22 segundos	Terminada	Nivel 3	100

Fig. 2 Performance evolution during the therapy period for a patient

3 Results

The testing is ongoing, but general feedback to date indicates that the system is easy to use and well accepted by both therapist and patient users. Patients are motivated to train harder, and clinicians consider the training movements and methodologies to be appropriate for complimenting clinical training with telerehabilitation at-home. The rehabilitation games are considered entertaining and well-aligned with training goals but difficulty should be better matched with ability for later stages of training. Also some technical improvements could make the system more robust (e.g., position tracking, delays).

4 Conclusion

Initial feedback from clinical usability testing of the complete system has yielded valuable insight on the system. Feedback will be taken into account in developing a next generation platform making use of the upcoming HTML5 capabilities, such as the *canvas* object and the greater operability over a large array of devices (PC´s, smart phones, etc.) and operating systems. As a result, the next version will allow for a truly seamless integration between online and offline features, particularly in conditions with intermittent Internet connectivity, thereby avoiding the current necessity of having an independent "offline" system.

References

[1] Perry, J.C., Zabaleta, H., Belloso, A., Rodriguez-de-Pablo, C., Cavallaro, F.I., Keller, T.: ArmAssist: development of a functional prototype for at-home telerehabilitation of post-stroke arm impairment. In: IEEE Int. Conf. on Biomedical Robotics and Biomechatronics, BioRob 2012, Rome, Italy, June 24-27 (2012)

[2] Rodríguez-de-Pablo, C., Perry, J.C., Cavallaro, F.I., Zabaleta, H., Keller, T.: Development of computer games for assessment and training in post-stroke arm telerehabilitation. In: IEEE Int. Conf. of the Engineering in Medicine and Biology Society, EMBC 2012, San Diego, California, USA, August 28-September 1 (2012)