EREHAB: UBIQUITOUS MULTIDEVICE PERSONALISED TELEREHABILITATION PLATFORM

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ABSTRACT

This paper presents the eRehab project, an innovative tele-rehabilitation solution development project. Its cloud-based architecture enables anytime, anywhere and multi-device rehabilitation therapy execution. Furthermore, it is based on the Universal Remote Console (URC) technologies and serious game technology, to achieve the maximum degree of user satisfaction. The flexibility provided in terms of location, client device, interaction means and content is understood as the path to maximize patients' acceptance and adherence rate.

1. INTRODUCTION

The life expectancy of citizens in modern societies is increasing rapidly. Such trend has a direct impact in the sustainability of healthcare systems in terms of public healthcare policies and budgets [1]. Rehabilitation services' users are mainly seniors. The solution presented in this paper tackles the needs detected in the healthcare rehabilitation process.

In this sense, firstly, there is an overload of the rehabilitation resources and personnel in the first phases at the hospital due to the need of individual attention. In this stage, rehabilitation is still a process regarded as strongly linked to facilities available at hospital or medical centres. As a consequence, the time required for the rehabilitation sessions is largely exceeded by the travelling time, and thus, daily activities are severely disrupted and additional costs for travelling need to be added. Finally, the adherence to home rehabilitation therapies has shown to be low.

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eRehab aims to answer to these needs by developing an ICT solution that helps elderly people maintaining a healthy and active lifestyle, while minimising side effects and improving healthcare systems' sustainability.

The eRehab platform aims to reinforce the rehabilitation process in its whole duration, in order to obtain a better and faster recovery of patients.

Likewise, the project targets to increase the motivation of the patients during the rehabilitation and a reinforcement of the adherence through digital entertainment technologies.

Finally, the project aims to provide the therapists with a tool to assess the patients' evolution, both real-time and offline. The solution will support the monitoring through different commercial wireless and low cost devices like Microsoft Kinect, Nintendo Wiimote or inertial sensors.

2. UBIQUITOUS MULTIDEVICE PERSONALISED TELE-REHABILITATION PLATFORM

eRehab expands the rehabilitation localisations, starting from hospital, moving home and giving the chance to continue outdoors or on travel. Apart from the localisation choice, the eRehab solution is implemented in three different client devices (PC, Smartphone and TV). Regarding the choice of client device, the inclusion of URC technologies [2], enables the easy personalisation of user interface (UI) and maximizes available interaction capabilities. Specific joint rehabilitation therapies (elbow, shoulder ...) require precise joint angles measurement: eRehab platform supports inertial sensors [3], providing a resolution beyond the limits imposed by other hardware, such as Microsoft Kinect.

Concerning the implementation of the platform, the project commits to open standards with the aim of maximising the interoperability with other systems. Specifically, the project is using the ISO 24752 standard [2] and the WSDL [4] specification.

eRehab platform's system architecture is depicted in Figure 1. The architecture is composed by three layers: the user layer, the cloud layer and the hospital layer. The cloud layer is composed by the UI resource and audiovisual content repositories, the hospital information system (HIS) and the rehabilitation services. Additionally, the Skype videoconferencing service is being integrated.

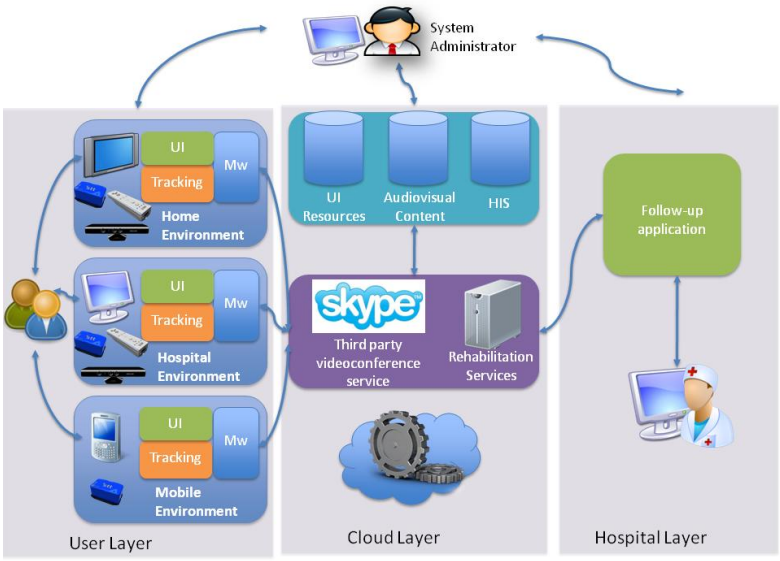

Figure 1: eRehab platform's system architecture

The UI resource repository is based on the resource server concept introduced by the URC technology [2,5] and follows the implementation guidelines provided by the URC Consortium in [6,7]. This approach will enable the provision of incremental support for new users with different needs and preferences, and to upgrade parts of the UI or the complete UI, depending on the evolution of user or maintenance tasks.

The audiovisual content repository has been designed to support different modalities, in order to respond to all user needs. Furthermore, the most ambitious scenario is targeting the provision of an audiovisual content merging the prescribed exercise with the user's feedback depiction on the screen.

The rehabilitation services are being defined following the WSDL [4] specification, making sure that the implementation is independent from the HIS system implementation in each hospital.

The user layer follows the same approach for the three different deployment environments. Each client is composed of a URC-based middleware, a tracking solution and a user interface. The URC-based middleware solution allows for the user interface personalisation and easy upgrading. Also, the URC-based middleware enables for the definition of a common interface specification for the different tracking systems, enabling the seamless exchange of the tracking systems.

The hospital layer is composed of a follow-up application, which allows the rehabilitators to prescribe a rehabilitation therapy to the patient and to revise the tracking results from the patient's therapy execution.

Additionally, the SkypeKit [8] product is being integrated with the UIs developed. Thus, a patient-doctor online videoconference will be provided for each considered scenario.

Finally, Figure 2, shows the initial audiovisual concept developed in tight collaboration with the Donostia Hospital rehabilitators through the Biodonostia Health Research Institute [9]. Virtual rehabilitator's look has been specifically designed, so that older adults find her both familiar and convincing enough to follow her instructions.

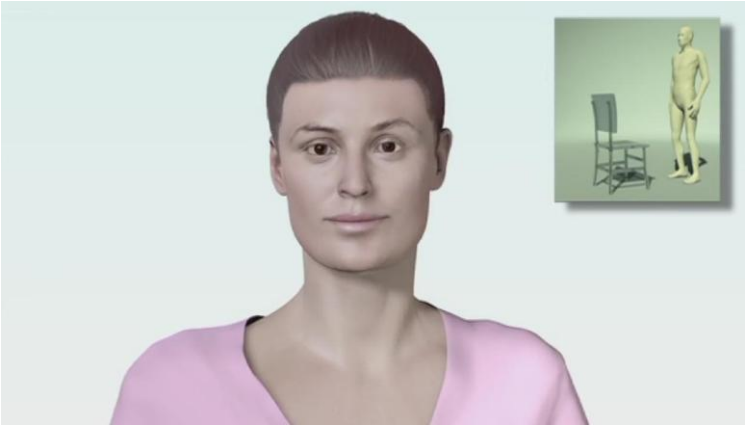

Figure 2: Virtual physiotherapist providing rehabilitation instructions

3. USER INVOLVEMENT AND ETHICS

The design of the audiovisual content has been carried out in tight collaboration with the Biodonostia rehabilitation staff. The developed audiovisual concept together with mock-up user interfaces will be tested at Donostia Hospital (Spain) in September by rehabilitation personnel and patients this autumn.

Specific questionnaires have been developed to gather both rehabilitators' and patients' voice regarding the designed audiovisual content paradigm and look, the inertial sensor's tracking system (the tracking system used in the first prototype) and the online communication system. The system will be updated on the basis of the results.

In addition, the project is carrying out an ethics supervision task, which supervises the ethical issues and provides the corresponding ethical committee with the needed documentation for the user tests.

4. CONCLUSIONS

The eRehab project provides the maximum flexibility regarding the customisation of the client application in terms of user interface, content and tracking system, as well as the location for the rehabilitation and the client device from which is used. Still, the project is in development

phase and needs to implement final client bundles that will attain the users' acceptance and adherence to the therapy.

In this sense, with the objective to achieve users' acceptance, a first round of user tests with patients with knee prosthesis will start soon.

The acceptance by the end users of the user interfaces and the content deployed over several client devices is key for the large scale implantation of the system and for its extension to other health services.

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