# Real–time Web–based Telerehabilitation Monitoring

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**Abstract.** Distance monitoring of rehabilitation exercises has been primarily conducted using two-way video conferencing. This paper presents a real-time web-based monitoring system that greatly enhances the capability of the clinician to direct rehabilitation therapies.

## 1. Introduction

The increase in Internet communication speed brought a significant improvement of information sharing. As of now, the main use of telerehabilitation is a two-way video conferencing structure, which would allow multiple people from different locations to hear and see each other. In the medical field it is apparent that this information is quite limited and would require advancement [1]. The ability to gather data in the form of numbers is an immediate improvement, however the ideal solution would be for the remote therapist to have a full understanding of a patients real-time movement as well as a continuous stream of performance, statistics and history data. This structure combined with an elevated use of a two-way video conferencing unit will allow the most information to be transmitted to a therapist, or group of therapists, from a patient, or group of patients, located in various remote sites.

## 2. Methods

The currently developed web-based telerehabilitation monitoring system utilizes a Java3D [2] application that can access the real-time data coming from the clinical sites. The clinical site consists of a Pan-Tilt-Zoom (PTZ) camera, which can be manipulated over the Internet, a microphone, and a virtual reality-based rehabilitation system (software and hardware). The hardware, the Rutgers Ankle (RARS) [3] and the Rutgers Master II [4], communicates the patient information to the local application, which will then send it to a remote server. It is from this server that the monitoring system retrieves its information and displays it in real-time to the remote therapist (see Figure 1).

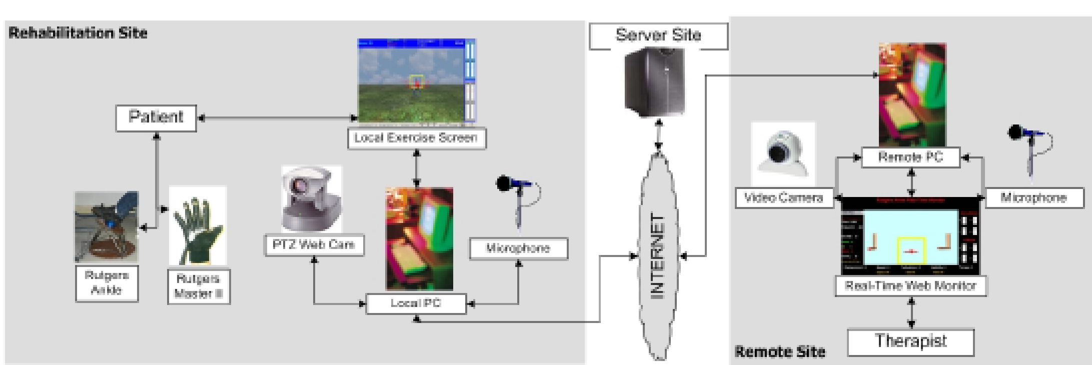
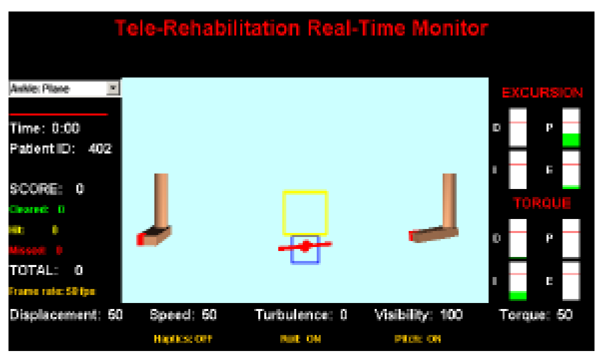


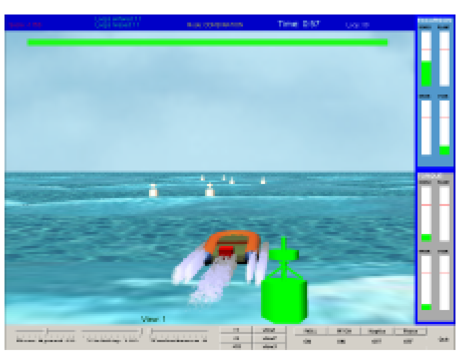

**Figure 1.** Tele-rehabilitation monitor hardware block diagram demonstrating the rehabilitation site (left) and the remote site (right). © Rutgers University 2002. Reprinted by permission.

The remote therapist monitors the exercises in real-time by viewing the application (Figure 2b, 2d) which contains most of the elements present at the local graphical user interface seen by the patient. (Figure 2a, 2c) The large center portion includes a three-dimensional mock-up of the patient's relevant body part (leg and ankle) viewed from several angles, in addition to a simplified version of the actual virtual reality application that they are currently exercising on. The right side of application shows performance bars, which indicate a target line as well as real-time movement demonstrating a patient's current level of effort. The top of the screen displays messages, which the patient's application relays as feedback, while the left and bottom displays current application configurations and patient data. This remote monitor also includes the ability to select which patient the therapist would like to view. Once selected, the information shown will match that patient. This allows a therapist to monitor multiple patients simultaneously in what we call multiplexed telerehabilitation.

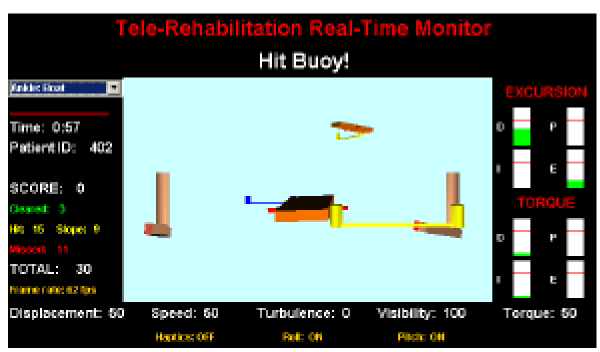

**(a)**




**(b)**



**(c)**




**(d)**

**Figure 2. Telerehabilitation graphics**

**(a)** Airplance Exercise and **(c)** Boat exercise at patient site, **(b, d)** therapist site

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## 3. Results

This real-time web monitoring system was tested with two subjects during a pilot trial in which the RARS was used to train individuals post-stroke to improve their walking ability. Patients participated in a 12 session training regimen over four weeks. During the last two weeks of training a therapist remotely monitored the session, while a therapist assistant remained in the clinic. Patients and the therapists were asked to rate their experience with the remote monitoring system.

The patients’ responses were unequivocal and divided. One patient was strongly opposed to the web monitoring and wanted to have the primary therapist present at the session every time. The second patient strongly endorsed the use of the distance monitoring system. The remote therapist adjusted the manner in which she gave feedback and conducted the sessions. Delays in the audio (due to a slow LAN) dictated that fewer verbal comments be made during the exercises, increasing the amount of summary feedback provided. In addition, aspects of performance that were observed differed between the onsite and remote sessions. Both the remote and local therapists found the real-time monitoring to be suitable for rehabilitation interventions.

## 4. Discussion

To our knowledge, this is the first description of a real-time web-based monitoring system for telerehabilitation, in which a 3D simulation is coupled with performance gauges, simulation data and video feedback from the remote site. Closing the gap between a patient and their doctor will broaden the range of treatment a patient can receive at home, as well as increase the number of patients a doctor can help.

The current model of telerehabilitation calls for either preconfigured exercise simulations or an assisting therapist on site. With the extension of real-time configuration controls, the therapist will not only have the ability to communicate with the patient, or judge his activity, but will have the ability to make modifications of the routines before and during an exercise. It is important to extend all capabilities of a local therapist to a remote therapist in order facilitate the idea of a full range of telerehabilitation interventions in the absence of a local therapist.

## References


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