# Salus: A System For Tele-Rehabilitation Using Kinect

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*Tele-rehabilitation may be a viable option for occupational therapists to meet treatment demand from increasing patient numbers. ADSC has developed* **Salus***, a system for tele-rehabilitation with the capability to analyze motion to help patients perform rehabilitative physical therapy (PT) at home. Online feedback is provided to both patients and doctors.*

## I. SALUS TELE-REHABILITATION SYSTEM

Video capture and virtual reality have been used successfully for rehabilitation, but mostly in interactive mode [1,2,3]. Our *Salus* system (Figure 1) offers the following additional features:

• Salus can turn most existing games into exercises for a variety of rehabilitation programs (separate leg, arm, or whole body to play game). For example, we have adapt TuxKart and TuxRacer games for control through specific movement of certain body parts, which is monitored via Kinect.

• Doctor and therapists can view all patients' records and detailed reports and graphs about their activities, training and tests results, which allow the doctor to understand the details of a specific exercise as well as the overall progress of the rehabilitation program (Figure 2).

• Therapists can update the rehabilitation program of the patients remotely depending on their progress, e.g. by increasing the target motion range of an exercise, or by adding new exercises into the patient's program.

The system consists of the following components:

• A Kinect RGB+depth camera, which tracks full body human motion non-intrusively in real-time.

• Software that runs tests and exercises, collects data from Kinect, and sends it to the cloud.

• Cloud service calculates and analyzes important indicators of movement such as potential and kinetic energy of movement, ability to keep balance, symmetry of movement, and functional ability of the body, as well as keeping clinical records for viewing the progress and history of rehabilitation for a given patient or patient group.
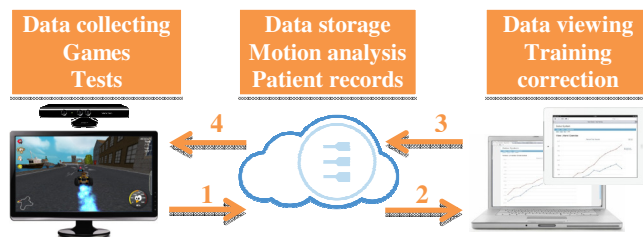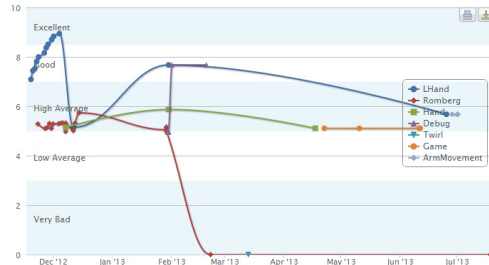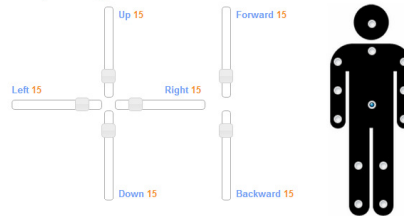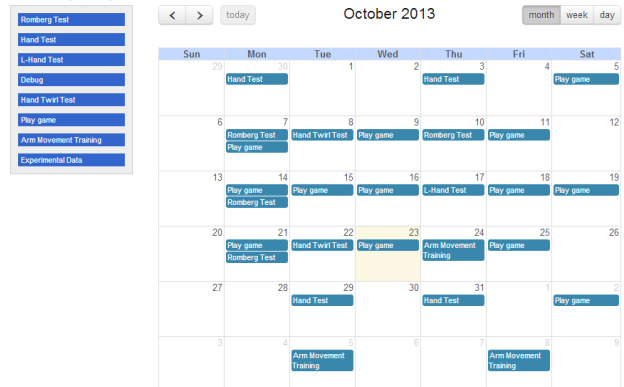


Figure 1. Patient – doctor interaction scheme: 1. Kinect and software at the patient; 2. Cloud Service; 3. Doctor's PC (interaction through web browser).



Figure 2. Screen view of the web interface for doctors and therapists. At the top is a graphical summary of all tests and exercises. "Body Settings" allows doctors to set up range of movement for rehabilitation and specific parts of the body. "Training Program" allows doctors to set up a rehabilitation schedule. "Exercises" and "Data" sections (minimized) provide full details on individual patients and exercises.

## REFERENCES

[1] P. L. Weiss, D. Rand, N. Katz, R. Kizony, Video capture virtual reality as a flexible and effective rehabilitation tool. *J. NeuroEng. Rehabil.* 1(12), 2004.

[2] L. Zhang, B. C. Abreu, G. S. Seale, B. Masel, C. H. Christiansen, K. J. Ottenbacher, Virtual reality environment for evaluation of a daily living skill in brain injury rehabilitation: reliability and validity, *Arch. Phys. Med. Rehabil.* 84(8): 1118–1124, 2003.

[3] B. Ni, Y. Pei, S. Winkler, Kinect for rehabilitation, Proc. iCreate 2012.