# The Rutgers Arm II Rehabilitation System

## A Case Series

D. Cioi, G. Burdea

Rutgers Tele-Rehabilitation Institute
Rutgers University CAIP Center
Piscataway, NJ USA
{dcioi, burdea}@caip.rutgers.edu

M. Holenski

JFK Johnson Rehabilitation Institute
Physical Rehabilitation Department
Edison, NJ, USA

*Abstract*—**The Rutgers Arm II system consists of a low-friction tilting table, a vision-tracked forearm support, a PC and a large display. Patients play a number of custom Java 3D games using their affected arm while supported by- or resisted by gravity through the table tilting. Four chronic post-stroke subjects (between 6 months and 5 years following stroke) trained for 12 half-hour rehabilitation sessions on the system over four weeks. Their Fugl-Meyer upper extremity subset scores improved 1 to 7 points (10 to 27 %) while arm reach area (measured on the RAII surface) grew between 156% and 307%. Both high- and low-functioning patients were able to play the games, and liked the system (average subjective evaluation of 6 out of 7).**

*Keywords-Arm; shoulder; rehabilitation; Fugl-Meyer; Java 3D; Rutgers Arm.*

## I. INTRODUCTION

The Rutgers Arm II system (RAII) [1] is the successor of the Rutgers Arm prototype [2] developed to train upper extremity (UE) function. Similar to the earlier version, it uses a low-friction table and low-friction sensorized forearm support, as well as a large display and PC-generated graphics. Unlike the Rutgers Arm, however, the RAII table tilts to assist or resist arm movement away from the trunk, and thus better gradate training difficulty. Furthermore, the earlier magnetic tracker was replaced with vision tracking of active markers placed on the forearm support and the contra-lateral shoulder.

## II. INTERVENTION

Four chronic post-stroke subjects (between 6 months and 5 years following stroke) trained for 12 half-hour rehabilitation sessions over four weeks. Each training session started with an arm reach baseline, to measure the area the patient was able to reach while assisted by- or resisted by gravity through the table tilt. Baseline data were used to customize three rehabilitation exercises programmed in Java 3D, described in more detail in [1]. Each exercise was played a number of times during a session and they alternated to increase patient engagement and prevent boredom.

Difficulty of the exercises progressively increased from the first to the last session, and the table tilt was also changed. The table was flat for the first two weeks of training for all subjects. Subsequently the table was tilted upwards 10° in Week 3 for subjects 1 and 3 who were higher-functioning patients. The table was tilted downwards 10° for the two lower-functioning patients (subjects 2 and 4). In Week 4 the table was tilted up
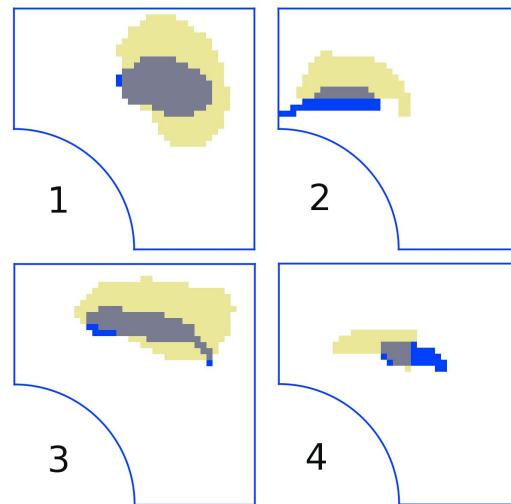
Figure 1. Arm reach baseline changes for Subjects 1 to 4. Fist session (blue) had the table flat. Last session (yellow) had the table tilted up 20° for subjects 1 and 3, down 15° for subjects 2 and down 10° for subjects 4. © Rutgers University. Reprinted by permission.

20° for the higher functioning subjects, and remained tilted down for the other two subjects.

## III. OUTCOMES

Fugl-Meyer UE scores improved 1 to 7 points (10 to 27 %) while arm reach area (measured by the RAII) grew between 156% and 307%. All patients were able to play the games, and complete the study. They liked the system giving an average subjective evaluation of 6 out of 7. Positive changes in the patients' activities of daily living were reported.

## REFERENCES

[1] G. Burdea, D. Fensterheim, D. Cioi and A. Arezki, "The Rutgers Arm II Rehabilitation System," Proc. Virtual Rehabilitation 2008, pp. 76, 2008.

[2] M. Kuttuva, R. Boian, A. Merians, et al., "The Rutgers Arm: An Upper-Extremity Rehabilitation System in Virtual Reality," CyberTherapy & Behavior, vol. 9, no. 2, pp.148-152, 2006.