# The Rutgers Arm II Rehabilitation System

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***Abstract*—The Rutgers Arm II trains primarily shoulder motor control, arm dynamic response, endurance and cognitive anticipatory strategies in virtual environments. It improves on our earlier Rutgers Arm by replacing magnetic tracking with a visual tracking and by the use of a training table that tilts. Pilot trials with a single subject showed clear dependency on table tilt angle. Further trials are ongoing.**

## I. System Description

THE Rutgers Arm II is a follow on to our 2005 Rutgers Arm prototype [1]. It continues to use a low-friction forearm support, which slides on a low-friction table surface. Unlike the Rutgers Arm, where the table was flat, the Rutgers Arm II table tilts four ways, with angles between 0 degrees and 30 degrees (Fig. 1). Another important difference is the replacement of the earlier Polhemus Fastrack magnetic tracker with a custom vision tracking system. The new tracker is un-tethered, making the arm movement more natural. Furthermore, there is no interference from nearby metal or magnetic fields.

The vision tracker uses an infrared camera mounted on a rigid frame on top of the exercise table, as well as LEDs placed at the table corners, on the forearm support and on the subject's opposite shoulder. The LEDs at the table corners are used for camera calibration, the two on the forearm support provide data on three arm movements (x, y, rotation), and the LED on the opposite shoulder is used to detect (unwanted) compensatory movements.

A multi-core PC workstation is used to run both the vision tracking and the simulation graphics. The vision tracking software, recently ported from a separate vision-dedicated PC, has been re-written in Java, and achieves a frame rate of 30 fps with a forearm movement resolution of 7 mm.

Training uses games written in Java 3D. Fig. 2 (top) shows the "Breakout 3D" game. It requires fast dynamic response and anticipatory strategies to bounce a ball into an array of blocks. Blocks placed to the left (or right) train mostly arm in-out movement. Blocks placed distally train lateral left-right arm movements. The "Pick-and-place" game trains motor coordination by asking subjects to follow a prescribed trajectory, for various placements of ball and target. "Treasure hunt" trains arm endurance.

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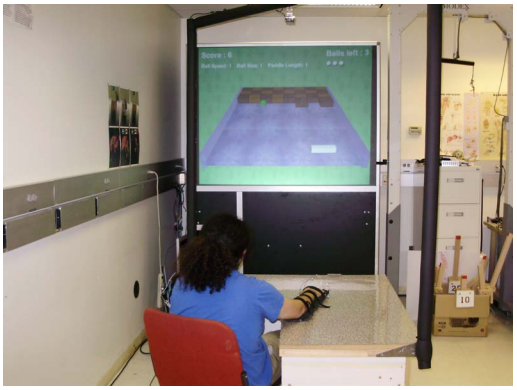

Fig. 1. The Rutgers Arm II. © Rutgers University.

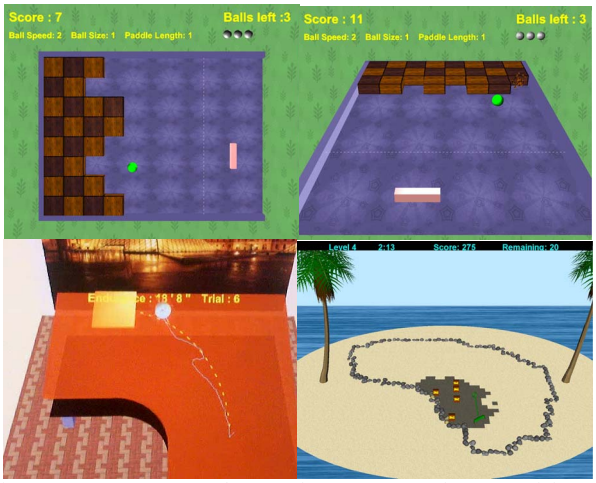


Fig. 2. Game scenes: top –the "Breakout 3D" game; bottom- "pick-and-place" and "Treasure hunt." © Rutgers University.

## II. Pilot Trials

A chronic post-stroke patient underwent five one-hour sessions over two weeks, with the table tilted from 10 to 25 degrees. Performance (path error, missed blocks and treasure hunt score) dropped for larger tilt angles. Further trials are currently under way.

## Acknowledgment

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## References

[1] Kuttuva, M., R. Boian, A. Merians, G. Burdea, M. Bouzit, J. Lewis, and D. Fensterheim, "The Rutgers Arm: An Upper-Extremity Rehabilitation System in Virtual Reality," *CyberTherapy & Behavior,* 9(2):148-152, 2006.