Nintendo Wii Remote for Computer Simulated Arm and Wrist Therapy in Stroke Survivors with Upper Extremity Hemipariesis

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Abstract— **The Nintendo Wii remote is a compact, readily accessible position, orientation, and motion sensing technology with blue tooth wireless communication. We have integrated the 3D position sensor to our existing gesture therapy system of computer simulated therapy exercises. We have also used pitch, yaw, and roll, from the Wii remote 3D accelerometer to navigate a fly-through of an arbitrary Direct-X generated terrain. The hardware-based orientation and motion sensing capabilities of the Wii remote complement vision-based systems and interface well with wrist exercises. It is conceivable to reduce the size of the technology such that each finger could have one or more accelerometers mounted with wireless communication. The Wii remote model is promising for integration into clinical and home-based rehabilitation exercise therapy systems.**

I. INTRODUCTION

EACH year over a million new stroke survivors add to those requiring physical therapy to recover the use of their upper extremity. Physical rehabilitation after stroke is a costly and time consuming process, the success of which depends on continued motivation and on self-administered, home-based therapy. To be successful the system must be simple and engaging. Computer simulated activities can be sufficiently motivating and require a suitable user interface. An ideal approach is a completely markerless (video-based) self-calibrating upper extremity 3D tracker and we pursued this with a two-camera working prototype. Our method is computationally intensive and does not yet capture independent wrist and finger movement which is a critical part of the rehabilitation process. When held in the hand the Wii remote senses wrist activity via hardware derived orientation and acceleration (Analog Devices; ADXL 330).

Fixed-frame, 3D position sensing is accomplished via a tiny high resolution video camera and a fixed IR emitting target. (performance can be improved by adding a second target, normal to the first) Distance is sensed by the apparent size of the target; line-of-sight is required.

We have integrated the vision-based part of the Wii remote position sensing system into a set of daily living simulations previously described as Vu therapy, T-WREX, and gesture

Fig. 1. A typical Direct-X landscape scene which the Wii remote-equipped patient can fly-through via slight wrist movements adjusted to the patient's abilities. Orientation sensitive accelerometers allow all of the processing to be done in the Wii remote and sent to the console via a blue tooth wireless channel; no line-of-sight required.

therapy. We are exploring the use of accelerometry to improve the efficacy of computer simulated therapy Accelerometers (Gyration Inc., UltraSense is a second option) do not require line-of-sight, reduce the computational load, and can be periodically updated by the vision system to provide more robust motion and position sensing. We used "open" C-callable libraries such as Wiili and Wii yourself to interface the Wii remote.

II. CONCLUSION

Simple sophistication and a large user base make the Wii remote attractive as a user interface for home-based rehabilitation systems. Nintendo has expanded its line to torso and lower extremities with the Wii Fit balance board.

Competing systems like PlayStation and X-box have more computing power than Wii and we are considering adapting to those platforms as well as improving our vision-only markerless 3D tracking system.

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