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Repurposing game tech

Excerpts from a paper by Rutger University team using Linux on XBox for stroke rehabilitation.

Abstract— We are witnessing the convergence of game technology (both software and hardware) with rehabilitation science to form a second-generation virtual rehabilitation framework. This is fortunate in view of the need to reduce system costs and thus facilitate adoption in clinical practice. This paper presents an Xbox-based physical rehabilitation system currently under development at Rutgers University. Unlike its high-end precursor aimed at hand training for patients post-stroke, the experimental system described here uses an inexpensive P5 game glove and Java 3D simulations. This results in significant cost savings, albeit with some tradeoff in functionality.

Our group has done pioneering research on the use of virtual reality for the upper-extremity impairment training of patients post-stroke [15-17]. Finger range of motion, fractionation and speed of flexion exercises utilized a CyberGlove [18] which costs about $10,000 and were programmed in WorldToolKit[19], licensed for $6,000. While trials performed at the University of Medicine and Dentistry of New Jersey were very encouraging, it was clear that the system was too costly. This paper presents initial work on a follow-up low-cost system currently under development at Rutgers University.

EXPERIMENTAL SYSTEM HARDWARE

The low-cost rehabilitation system that is being developed for hand rehabilitation post-stroke is shown in Figure 1. It consists of a modified Xbox that runs the training exercises, a P5-glove which measures the flexion of all fingers as well as the wrist 3D position, a graphics display (in our case a colormonitor), and Internet connection to a laptop used in software development. The reasons for choosing the Xbox as computing platform are cost, large number of existing systems in patients'homes and the possibility to modify its hardware as required for use as a rehabilitation platform.

EXPERIMENTAL SYSTEM SOFTWARE

The Xbox hard drive has the Fat-x special file system designed by Microsoft that works only with the Xbox kernel. For this reason there are some limitations on the file systems that can be installed on the Xbox hard drive. The Linux distribution installed on the Xbox is Xebian, a special distribution based on Debian specially tuned for the Xbox. The Xebian operating system was installed as it has kernel supportfor an open source implementation for the Fat-x file system. This allowed the installation of the GNU/Linux operating system on an image file on top of Fat-x file system. Thus to the Xbox original operating system, GNU/Linux looks like a normal file on the disk. This installation method has the advantage that it preserves the original Xbox software, while allowing us to run a custom operating system that transforms the Xbox into a machine suited for virtual rehabilitation exercise development.

The P5 glove used in the present system is supported on Linux, yet manual modifications on the kernel side for the glove were needed for the glove to work properly. The default kernel had to be patched and recompiled, and the communication to the Xbox through USB driver that the glove producer provides was implemented in user space, using the libusb-0.1.8 library.

Exercises were first developed and tested on a laptop, then downloaded to the Xbox. Thus the same exercises would run on both platforms, as long as Linux (and not Windows) was used.