

Home Stroke Telerehabilitation System to Train Recovery of Hand Function



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Purpose

1. To see whether improved function and brain reorganization demonstrated in an earlier, clinic-based stroke rehabilitation study [1,2] could be replicated in the home.
2. To determine whether improved hand function and brain reorganization stem from repetitive movement or from cognitive processing associated with learning how to move the finger accurately.
3. To understand why complex tasks, such as tracking, that require cognitive processing appear to promote greater neuroplastic change than simple tasks [3].
4. To pilot a home-based tracking training system that could be used without a therapist present.

Design requirements

1. Hand and wrist involved in a tracking task that requires concentration.
2. Easy to use by those without technical expertise.
3. Telecommunication feature for periodic, real-time interaction with a therapist for monitoring, motivating, and assistance.
4. Telecommunication assumes home land-line, but no broad-band internet.

System overview

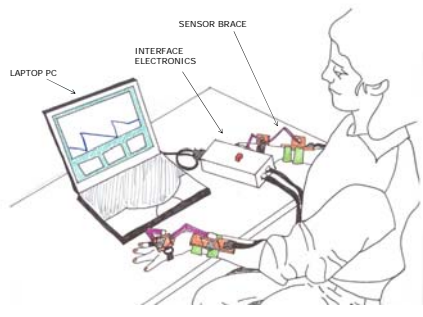
1. Sensors monitor bilateral finger and wrist motion. Potentiometers and custom hand brace.
2. Electronics box with microcontroller interfaces sensors and control buttons to PC via serial port.
3. Visual Basic program on PC implements tracking task and experiment control.
4. Voice, 2-way video and data tele link via web cams, cell phone, and land-line dial-up internet access.

Evaluation

System placed in the homes of 24 subjects with chronic stroke and impaired finger motion. 20 of 24 enrolled in formal treatment assessment study

References

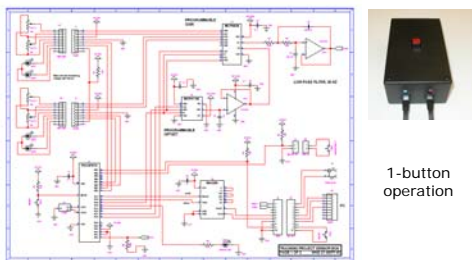
- [1] Carey, J. R., Anderson, K. M., Kimberley, T. J., Lewis, S. M., Auerbach, E. J. and Ugurbil, K., 2004. fMRI analysis of ankle movement tracking training in subject with stroke. *Exp Brain Res*, 154, 281-290.
- [2] Carey, J. R., Kimberley, T. J., Lewis, S. M., Auerbach, E., Dorsey, L., Rundquist, P. and Ugurbil, K., 2002. Analysis of fMRI and Finger Tracking Training in Subjects with Chronic Stroke. *Brain*, 125, 773-788.
- [3] Plautz, E. J., Maliken, G. W. and Nudo, R. J., 2000. Effects of repetitive motor training on movement representations in adult squirrel monkeys: role of use versus learning. *Neurobiology of Learning and Memory*, 74, 27-55.



Hand sensor brace

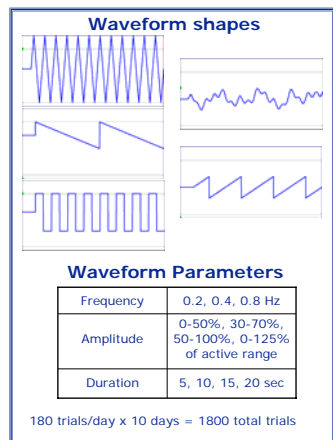


Sensor interface electronics

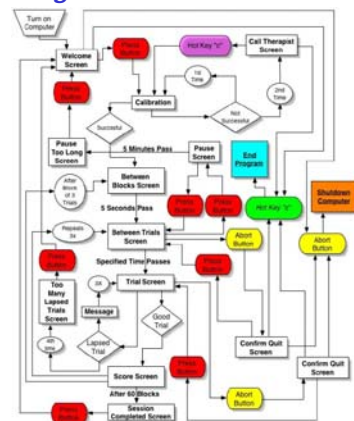


1-button operation

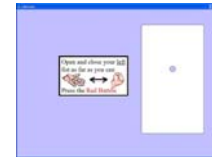
Complete home system



Program flow



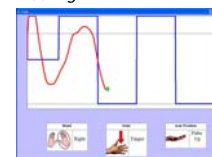
Calibration



Trial prep



Tracking



Feedback



Pausing



Auto shutdown



Evaluation

System placed in homes of 24 subjects

- 24 subjects with chronic stroke and impaired finger motion
- 20 in treatment assessment study
- 2 completed treatment assessment, but fMRI data contaminated
- 1 in separate pilot study
- 1 dropped; unable to self-don sensor brace
- 10 to 14 days to complete 1800 trials
- Distances from the U: 2 to 305 mi (median 18 mi) plus one at 1,057 mi

Installation & equipment faults

- 15 subjects installed system themselves at home, after instruction in clinic
- 9 required home visit to install
- 3 required follow-up visits to fix equipment
- 23 successfully completed at least one tele-video session

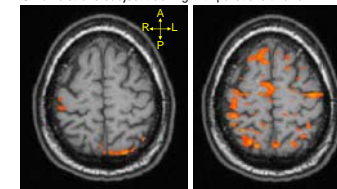
Useability

- Telephone interview survey (n=13)
- 13 said "computer easy to use"
- 9 could don/doff sensor brace independently
- 12 said "easy to communicate during tele-sessions"
- 1 said "system interfered with daily life"

Treatment evaluation measures

- Box and Block Test
- Jebsen-Taylor Hand Function Test
- Range of Motion
- Tracking Accuracy
- fMRI: Voxel count, Intensity, Laterality index

Chronic stroke subject tracking with paretic left hand



Pretest Posttest

Next generation

- Simpler hand sensor mechanics
- Wireless
- Simpler tele-conferencing
- Additional joints

Acknowledgement

This project is supported by National Institute on Disability and Rehabilitation Research (US Dept. of Education #H133G00145). Address correspondence to W. Durfee, University of Minnesota, 111 Church St SE, Minneapolis MN 55455 (tel: 612-625-0099, email: wkdurfee@umn.edu).