Computer-based Hand Rehabilitation based on Augmented Feedback

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Introduction

Hand rehabilitation programs aim at improving motor, sensory and cognitive performance so that the patient can execute everyday functional tasks efficiently. In this direction, technology can be beneficial providing the therapist with quantitative & objective evaluation means as well as the patient with feedback, knowledge of performance and motivation**[1,2]**.

System Description

The HandTutor™ system consists of an ergonomic glove, available in 5 sizes for left & right hand, which communicates with specialized software. HandTutor™ permits the performance of isolated and inter-joint finger and wrist exercises through flexion and extension movements driven by suitable audiovisual feedback.

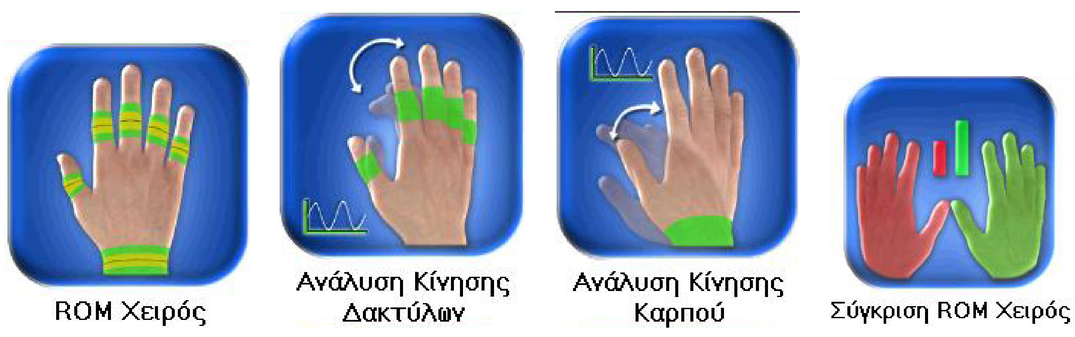
Sensors & Data Acquisition

- Displacement sensors for distance & speed measurements at individual fingers and wrist.
- Signal acquisition and preprocessing at glove integrated module encased in unobtrusive housing.
- Real-time USB connectivity to dedicated software suite (MediTutor) for therapeutic evaluation and treatment.

Evaluation Tests

The system allows the measurement and evaluation of the kinematic parameters of the affected hand, such as functional range of motion and speed of movement, through static and dynamic testing procedures.

- ROM evaluation for individual fingers and wrist
- Motion analysis tests for fingers and wrist (flexion/extension frequency for predetermined time period)
- ROM comparison test between hands



Therapeutic Procedures

Exercises are provided in the form of interactive rehabilitation computer games that can be customized to patient's motor and cognitive abilities.

- Therapeutic treatment with the use of an array of computer games (Serious Games).
- High level of game customizations for addressing specific patient impairments.

System Evaluation

- Assessor-blinded, randomized controlled pilot trial conducted at the Reuth Rehabilitation Unit, Israel
- Study on traditional therapy with additional HandTutor treatments against traditional therapy only. 15 consecutive treatments.
- 31 stroke patients in the sub-acute phase. Experimental group n=16. Control group n=15.
- Evaluation based on the Brunnström-Fugl-Meyer (FM) test **[p=0.041]**, Box and Blocks (B&B) test **[p=0.015]** & improvement parameters of the HandTutorTM software **[performance accuracy x-y axis p<0.0003]**.
- **Significant improvement observed within the experimental group (95% confidence intervals) compared to control group.**

Conclusions

- HandTutor™ system applied & evaluated on stroke patients**[2]** showing combination of HandTutor™ & traditional hand rehab significantly more effective assessed by dexterity and impairment tests.
- Clinical studies in progress on orthopedic hand injuries to test relationship between HandTutor™ evaluation and exercise performance compared to Functional Activity Score.
- Further advantages on the treatment of hemiplegic cerebral palsy**[3]** with related technologies.
- **Pilot studies in Greece currently being conducted at major rehabilitation hospitals.**
- Availability of additional sensors for knee, elbow & ankle in early 2011.
- **Solid patient motivation via augmented biofeedback providing simultaneous knowledge of performance (KP) & knowledge of results (KR).**

References

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