Designing a Sensorized Glove for Post-Stroke Rehabilitation

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Every **40 seconds**, someone in the United States has a stroke.

Approximately **60%** of the individuals who survive a stroke require rehabilitation.

Long-term impairment of the arm

The recovery of hand functions is of paramount importance.
Robotic and virtual reality training = great potential in the field of rehabilitation

Preliminary clinical tests: positive results

Multiple repetitions + progression + feedback = increasing effectiveness
De Rossi’s group glove able to detect hand kinematic configurations.

A mask of 20 Sensors (S1 – S20), connected in series.

The mask covers the movement of:
- Distal phalanges
- Intermediate phalanges
- Proximal phalanges
- Metacarpals
• Accurate data
• Keep the sensors close to the hand to make sure they read the movement
• The useful number of sensors printed on the mask

• Wearability: easy donning and doffing

• Breathable
The glove technology is combined with a robotic system (Armeo, Hocoma AG) for upper extremity rehabilitation.

While using the glove the patients are asked to do same games and perform the following movements:
• Open
• Close

They are not asked to perform:
Fingers abduction-adduction
Sensors used:
2 – 3 (thumb)
5 – 7 (index)
9 – 11 (middle)
13 – 15 (ring)
17 – 19 (pink)
The Mask

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The new mask is realized with **11 sensors** and **12 connections**.
Preliminary tests show good signals
• Wearability
• Hard to fit
• Easy to take off
• Lycra slips on the hand and let to lose the signal
• Not breathable
USABILITY TEST: GLOVE

1. Attachment: Physical feel of the glove on the body
2. Harm: Physical effect, the level it grates on your hand
3. Harm: Physical effect, the level it grates on your forearm
4. Tight: How much is tight-fitting?
5. Slip: The level the glove slips on your skin
6. Wearability: The difficulty to wear the glove

- Very Low
- Quite Low
- Low
- Medium
- Quite High
- High
- Very High

7 patients:
Adults with upper extremity paresis
  - Able to move UE against gravity 25% of the range
  - Able to understand directions and follow simple instructions
  - Medically stable
4 Females – 3 Males age 28- 65 
Affected side:
4 right
3 left
no skin sensation because of the stroke (all answer very low)

Patients reported altered sensation and excessive perspiration when wearing the glove

13 Common users:
6 Females – 7 Males Age: 26-43
M<1>H (because of lycra and glove length- not breathable)
VL<2>L
VL<3>L
M<4>H
M<5>H
M<6>H

1.Attachment:
2.Harm:
3.Harm:
4.Tight:
5.Slip:
6.Wearability
Glove Development
Glove Development

Thermoplastic clips
Glove Development

Pre stressed steel clip
Preliminary shows that the glove provides good tracking of hand movements.
The glove technology could be used with a wireless Unit developed by Jean Luprano's division in CSEM (Centre Suisse d'Electronique et de Microtechnique, Neuchâtel, Switzerland)

The wireless provides good signals
Conclusion and Further Developments

• A new glove:
  No fabric on the palmar side of the hand
  Clip components to avoid migration of the glove

• A mask with a reduced number of sensors (from 20 to 11) provides a shorter and more comfortable glove

• A box containing the wires in order to not interfere the natural movements.
A new glove has been developed to improve usability, wearability, and functionality of the entire system.

Wearability and fabric comfort will be evaluated with usability tests.

Data Collection to figure out the effectiveness of the new mask will be held.
Thanks for the attention
Any questions?
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