WiseSkin RTD 2013

# WiseSkin
# Haptic Feedback for Hand Amputees

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## Introduction

The WiseSkin project targets the restoration of a natural sense of touch to persons using hand prosthetics. Current myoelectrically-controlled hand prostheses normally lack tactile feedback, which limits their functionalities and user acceptance. This work proposes a non-invasive tactile sensory feedback system, consisting of miniaturized sensors, wireless communication module and mechanical actuators

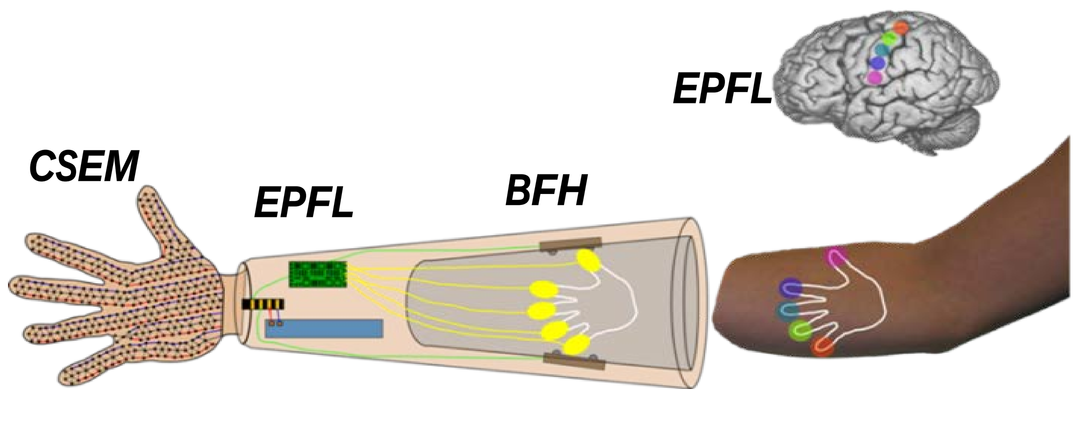


*Fig.1 WiseSkin system overview*

## Haptic display design

So far, two types of haptic display were designed: vibrotactile (Fig. 2a) using a linear resonant actuator (LRA) and eccentric rotating mass (ERM) and a mechanotactile display (Fig. 2b).

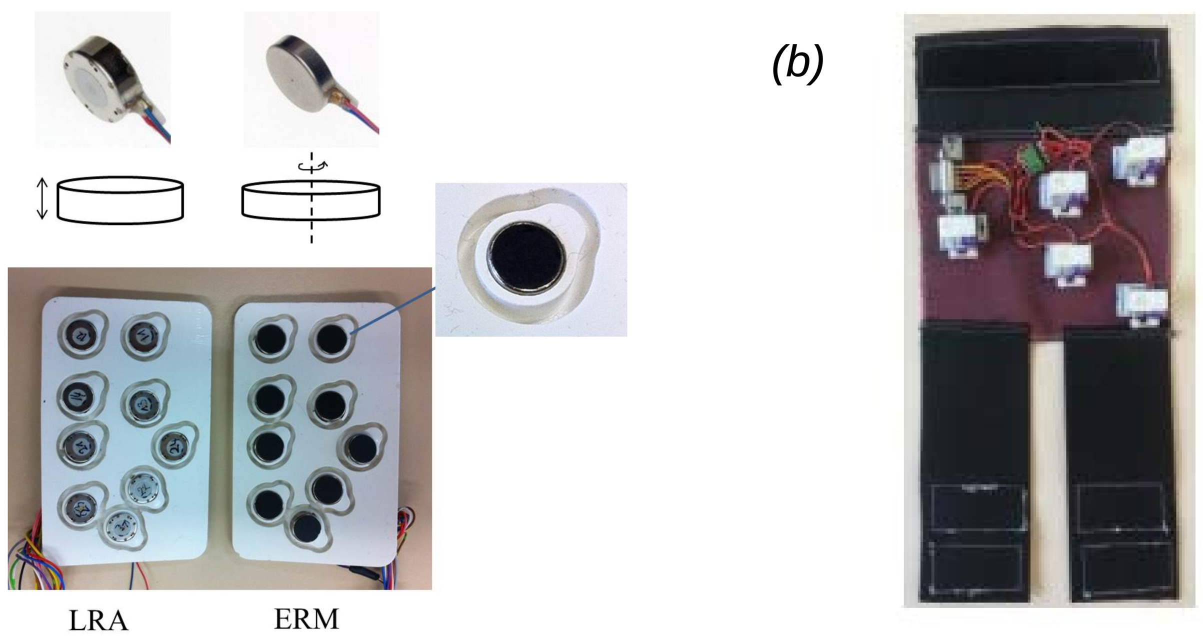


*Fig.2 (a) Two types of vibrotactile display using LRAs and ERMs. (b) Mechanotactile display using servo motors*

The preliminary results from tests on healthy subjects have shown that:

**For vibrotactile**
- LRA has a lower minimal detectable level.
- ERM has smaller just noticeable differences.
- The minimal two-point discrimination distance is between 3 and 4 cm for both LRA and ERM.

**For mechanotactile**
- With 5 cm distance, the localization rate is 88%.
- The discrimination rate of different applied force is 80%

## Sensory feedback model

To better understand the system, as well as to reduce development cost and time, a tactile system model is built. This model includes:

- A prosthetic hand in 2D with sensors
- A tactile sensor data fusion block model
- Phantom map models (shown in Fig. 3) .

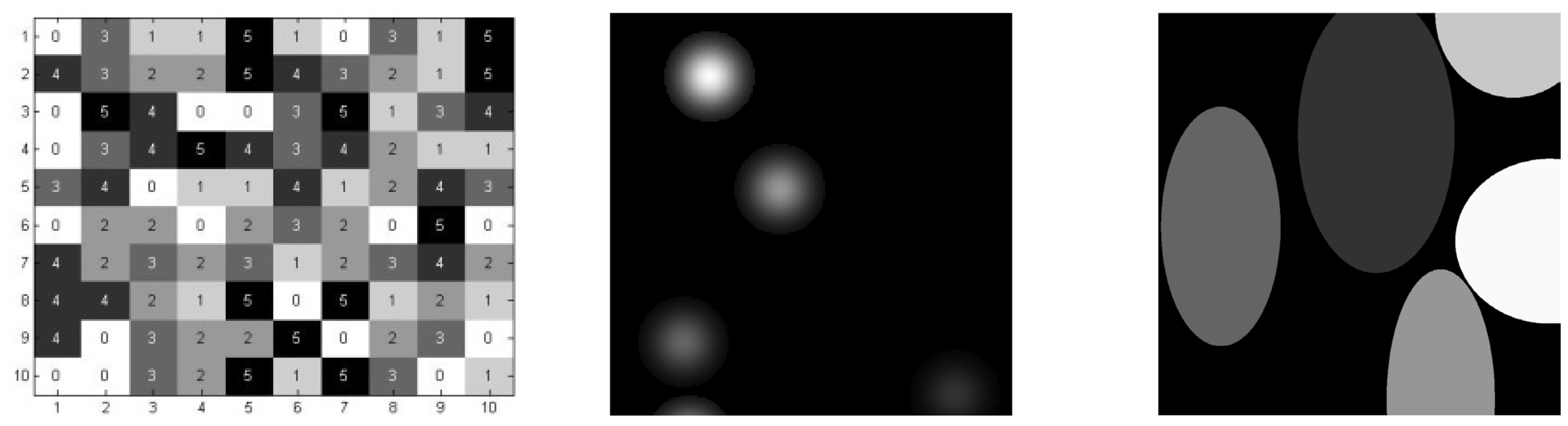


*Fig.3 (a) Random phantom map model (b) Gaussian distribution phantom map model (the phantom sensation is in Gaussian distribution: the center of each phantom finger has the strongest sensation.) (c) Ellipse phantom map model (each phantom finger is in the shape of an ellipse)*

The goal of the learning algorithm is to find the best stimulation pattern with minimal testing. Several methods have been implemented on different types of phantom map models:

- Neural network
- Support vector machine
- Group testing

Preliminary results have shown that:
- The approach that uses a support vector machine is suitable for all the phantom map models tested. With 200 training data, the average error rate is 8%; with 100 training data, the average error rate is 14.4%; with 50 training data, the average error rate is 19.7%.
- Group testing is suitable for Gaussian phantom map model and ellipse phantom map model. The average testing iteration needed to find sufficient stimulation pattern is 300.

## nclusion

Our current work focuses on the design of haptic displays and modeling of the tactile feedback system. The two types of haptic displays presented have shown potential to be used as sensory feedback. Future research will focus on using complex pattern to increase the perception resolution. A 2D hand model, a sensor data fusion block, and a phantom map model are implemented in MATLAB. For the mapping algorithm, group testing has shown to potentially achieve the optimal fast. But since the real distribution of phantom map areas is unclear, further researches on phantom maps will help us build a more realistic model.

H. Huang, et al., "Data fusion for a hand prosthesis tactile feedback system," *Biomedical Circuits and Systems Conference (BioCAS), 2014*

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