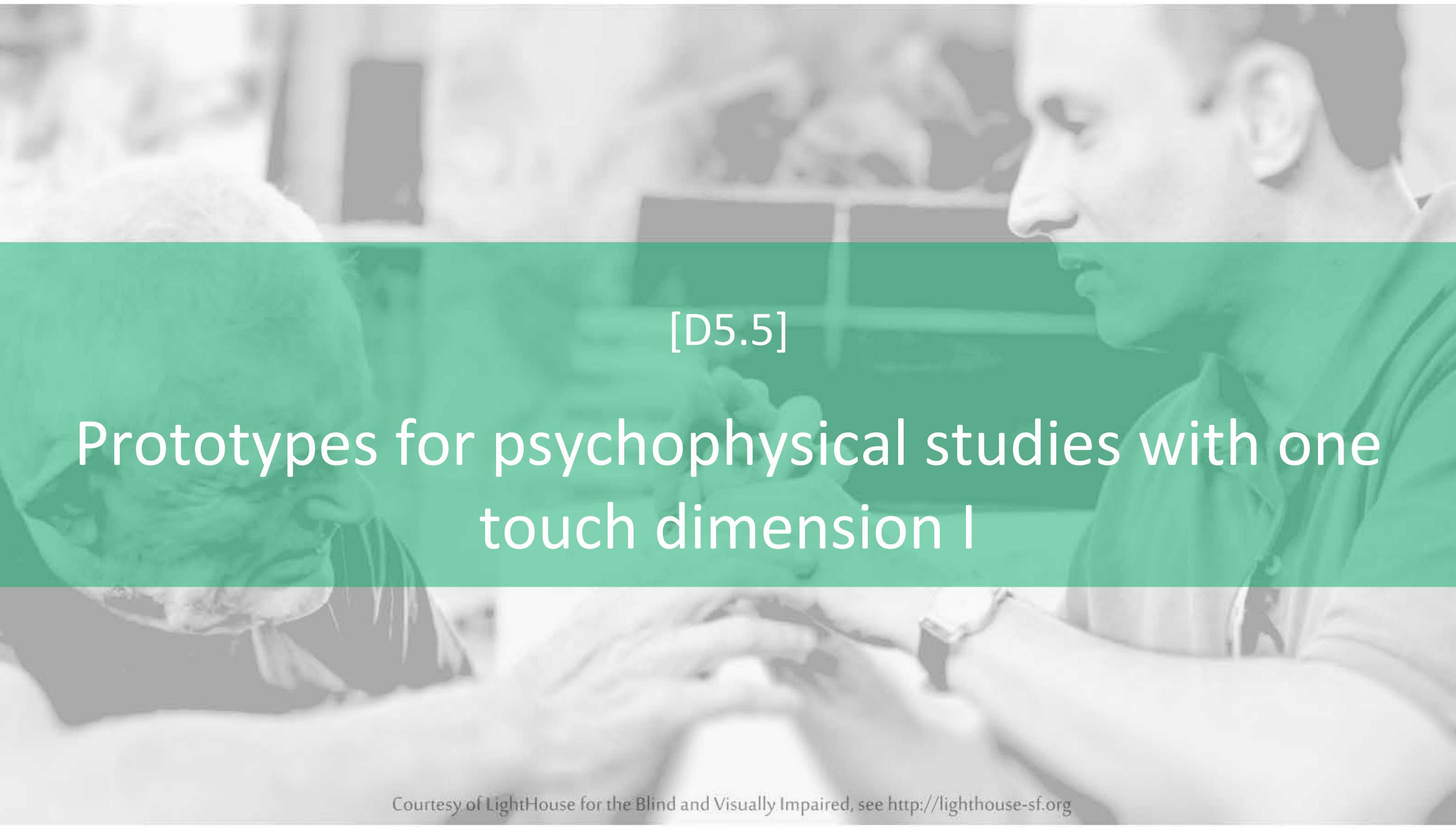
SUITCEYES

1 Jan 2018 - 31 Dec 2020

Smart, User-friendly, Interactive, Tactual, Cognition-Enhancer, Yielding Extended Sensosphere
Appropriating sensor technologies, machine learning, gamification and smart haptic interfaces



[D5.5]

Prototypes for psychophysical studies with one touch dimension I

Courtesy of LightHouse for the Blind and Visually Impaired, see http://lighthouse-sf.org

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Dissemination level		
PU	PUBLIC, fully open, e.g. web	X
CO	CONFIDENTIAL, restricted under conditions set out in Model Grant Agreement	
CI	CLASSIFIED, information as referred to in Commission Decision 2001/844/EC.	

Deliverable Type		
R	Document, report (excluding the periodic and final reports)	
DEM	Demonstrator, pilot, prototype, plan designs	X
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	

Deliverable Details	
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Lead organisation	HB
Lead member	Nils-Krister Persson

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v02	2018-05-15	First draft for internal review	Nils-Krister Persson / HB
v03	-	Second draft addressing review comments submitted to HB	-
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LDQR	Review / Mauricio Fuentes	
HB	Review / Jonas Andersson	
CERTH	Review / Panagiotis Petrantonakis	

Glossary	
Abbr./ Acronym	Meaning
SUITCEYES	Smart, User-friendly, Interactive, Tactual, Cognition-Enhancer that Yields Extended Sensosphere
1D	One dimensional, one dimension here representing one modality
Modality	Modality is a particular way in which information is to be encoded for presentation to humans. In this document we refer to sensory modalities: visual, auditory, vibro-tactile, olfactory, gustatory, kinesthetic, etc.
knitting	One of the most important fabric forming processes together with weaving
WPx	Work package (1 to 8)

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Executive Summary

The deliverable 5.5 *Prototypes for psychophysical studies with one touch dimension I* (which is of type Demonstrator) is focused on the creation of a textile prototype. Here the choices and actions taken in the production of this knitted prototype are described.

For a first study of the possibilities of non-audial, non-visual communication thermal modality was chosen. This was realized as a knitted swatch with Peltier elements. Peltier elements are able to deliver heat as well as cooling. It turned out possible to produce these textiles on industrial scale knitting process.

Prototype producing project

As described in *T5.3 Generation of "1D" of textile prototypes* from which D5.5 is an outcome, the focus was to make simple, early, textile prototypes that are not ready-made garments but swatches. For the moment, one dimension (1D) textile prototypes were developed, meaning that only one sensory modality (sight, audial, vibro-tactile, etc.) was considered. This is later to be extended to two types of sensory modalities (2D) in D5.7, *Prototypes for psychophysical studies with two touch dimensions.* This deliverable is the first step to reach one of the project's goals, which is to develop a full-fledged HIPI, Haptic Intelligent Personalized Interface.

The aim is to:

- Investigate the possibilities to make textile (non-visual, non-audial) communicative devices
- Investigate the possibilities to make up-scaled industrial products to make the first prototypes for psychophysical experiments (*T 6.1 Testing textile prototypes with one touch dimension*)

Choice of modality

The modality chosen for this iteration is thermal. There are several reasons for this:

- Compared to vibro-tactile modality there are far less examples on thermal based communication. This is true both for the number of prototypes that are being developed as well as scientific papers. As knowledge seems to be meager for thermal actuators, the area is of scientific interest and relevant for further exploration as a possible modality for the HIPI.
- Thermal modality is of interest in a broad perspective relating to textile comfort in general and of special relevance in products such as outdoor jackets with thermal heating cables, heating socks, cooling vests for sports etc.
- Heating as well as cooling is interesting for the gaming society for enhancing the experience being exposed to for example wind and snow. It is also of use for enhancing other kinds of media experiences.
- Heating tests are done within medicine testing such as examining for peripheral neuropathy. Insights from medicine and insights from our (future) studies could be shared and thus enrich several different fields.

Thermal source

As thermal source Peltier elements (Figure 1) has been used. Based on the thermoelectric effect/Seeback effect which is that an arrangement of two kinds of special materials could create "moving" of heat so that areas of both heating and cooling could be achieved. This is done and controlled by an applied voltage. Switching polarity also switch which side of the often squared-form Peltier element that is cooling down and which is heating up. Thus a Peltier element is more versatile than an ordinary heating cable. Peltier elements are made of ceramic materials and are therefore hard and brittle. Thus they need to be embedded in textiles if used for wearables. This is a construction parameter that has been taken into account. When in the cold mode they also generate heat (on the opposite side), this heat must be transported away for which a heat sink is needed. This is also a design parameter. At this stage there is no concern in the textile construction for electrical cables for the power supply. The control and powering of the Peltier elements was developed in D5.2 *Driving and control unit for the textile*. This is already from the beginning designed for not only thermal actuators but also other modalities such as driving electrical vibro-tactile motors.

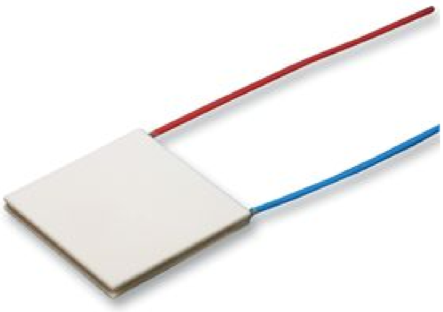

Figure 1. Peltier element with two connecting wires. Depending on polarity either the upside of the (3 by 3 cm) square is becoming cold and the reversed side heated or the opposite.

The textile prototype

Based on this a textile prototype (DEMO) has been developed (in fact over 20 different prototypes), see figure 2.

The textile technology of flat knitting was chosen. This is due to a number of reasons:

- It is a versatile process where different materials (including thermally conducting metal yarns) could be incorporated
- It does not demand as much prearrangements as weaving - the other major fabric forming process
- A certain amount of elasticity can be obtained which enables freedom for the morphology
- It is an industrial relevant process
- It creates a finished device in one production process without the need for any post steps such as sewing

The textile prototypes consist of normal, well-known bulk yarn, polyamide that is united with metal (silver pleated yarn) yarns. By this a high contrast of thermal conductivity is achieved. Beneath (not shown in the figure) pockets are integrated (without extra production steps) where the Peltier element could be inserted. The pockets also create some pressure and enhance body contact with the metal fabric part.

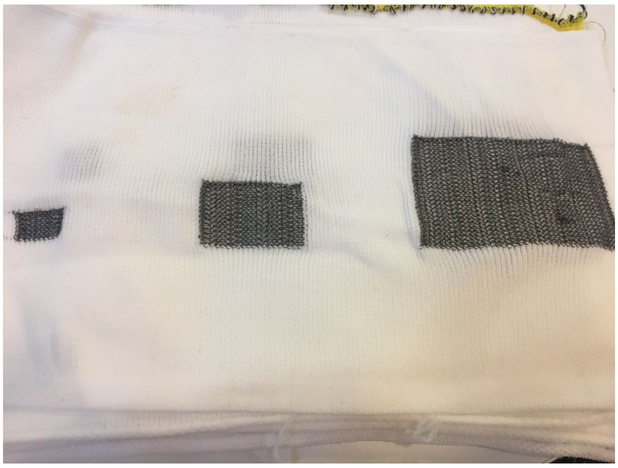

Figure 2. Polyamide (white) with intarsia knitted “pixels” of metal silver yarns. Here three sized are shown. The middle of approximately the same size as the Peltier element. The total swatch is ca 30 times 20 cm. The yellow string in the top is the edge of the swatch. Not seen are pockets beneath the “pixels”.

The aim has been to create “thermal pixels” a new concept that could be used for (non-visual, non-audial communication). The pixels are presumed to be spatially focused and not blurred for optimal communication. Therefore, contrast in the material (bulk yarn and metal) was chosen.

In figure 3 a cross section of the swatch is visible. By using what is called a spacer fabric knitting a certain thickness of the fabric is obtained. This enables the incorporation of pockets as mentioned above and the integration of different materials to be produced.

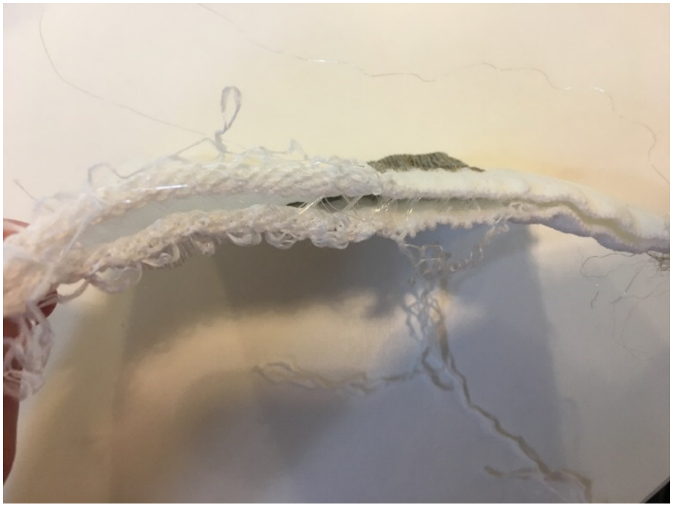

Figure 3. Close up of the knitted structure

Furthermore, the knitted swatches were integrated in a textile based strap were different distances between the “thermal pixels” could be adjusted. Thus different body parts such as lower and upper arm, back, shoulder could be contacted in a practical way.

Conclusion

Using knitting on industrial flat knitting machines is suitable for up-scaling from a production and commercial perspective. *The manufacturing is shown to be possible.*

Psychophysical studies (WP6) are underway based on this.