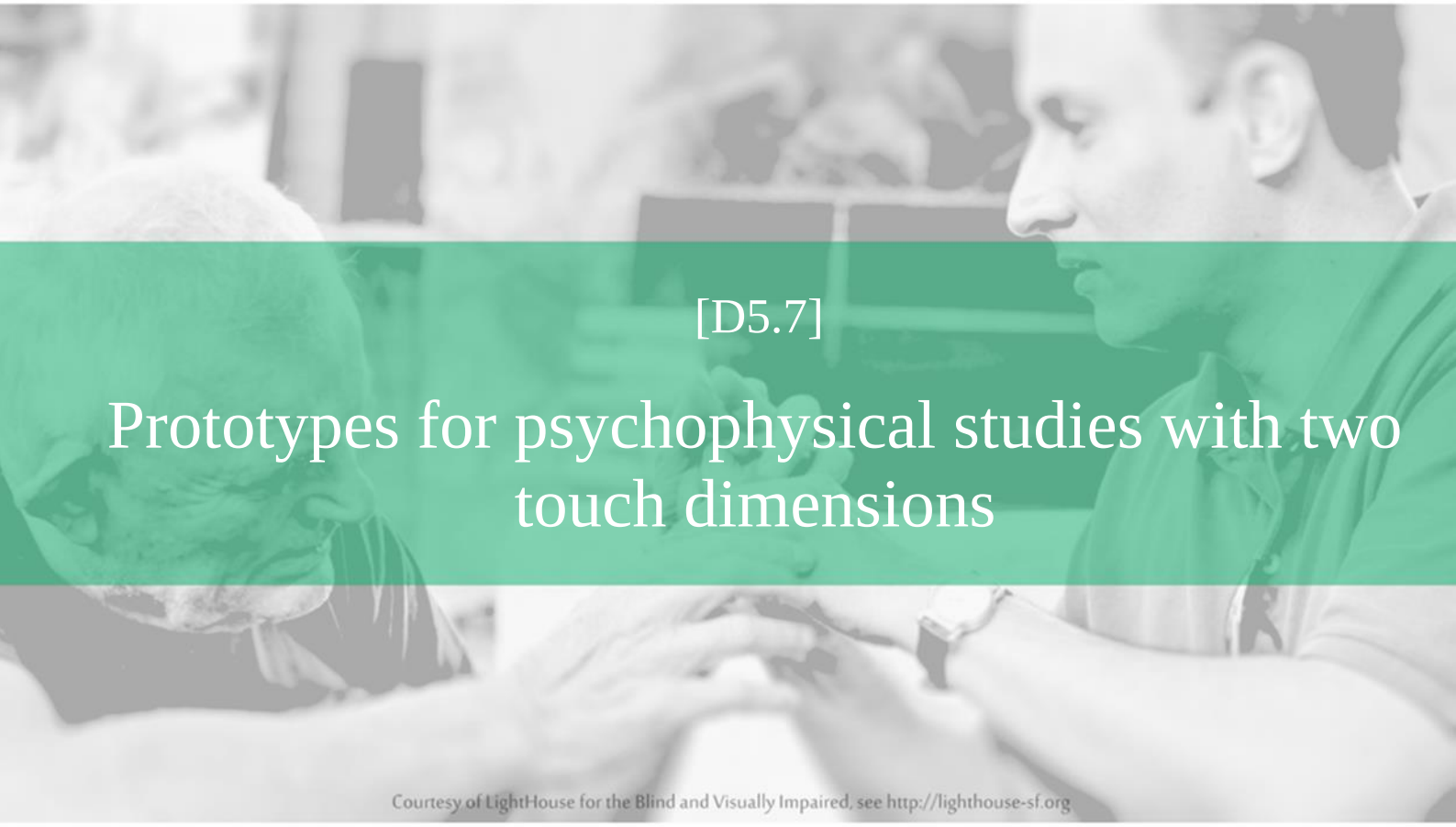
SUITCEYES

1 Jan 2018 - 31 Dec 2020

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



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

[D5.7]

Prototypes for psychophysical studies with two touch dimensions

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 780814.

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	
Deliverable number	D5.7
Part of WP	5
Lead organisation	HB
Lead member	Nils-Krister Persson

Revision History			
V#	**Date**	**Description / Reason of change**	**Author / Org.**
v0.1		Structure proposal	Li Guo / HB
v0.2	17/06/2019	First draft for internal review	Eva Lindell, Li Guo & Nils-Krister Persson / HB
v0.3		Second draft addressing review comments submitted to HB	Li Guo & Nils-Krister Persson / HB
v0.4	23/06/2019	Final draft after PC's comments	Li Guo & Nils-Krister Persson / HB
v1.0	27/06/2019	Final draft submitted to the EU	Thomas Bebis / HB

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Partner	**Contribution type**	**Name**
LDQR	Review	Mauricio Fuentes
UNIVLEEDS	Review	Sarah Woodin

Glossary	
Abbr./ Acronym	**Meaning**
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.
Plain weave	One of the most important common and tightest weave structure, in which the weft alternates over and under the warps.
SUITCEYES	Smart, User-friendly, Interactive, Tactual, Cognition-Enhancer that Yields Extended Sensosphere
VBM	Vibration module
WPx	Work package (1 to 8)

Summary:

The deliverable *5.7 Prototypes for psychophysical studies with two dimensions* is focusing on developing textile prototypes as platforms for integration of vibrotactile and thermal actuators. An innovative 'one-size-fits-all' garment construction, i.e. a plain weave vest, has been proposed, as at this stage it is not possible to make many different garment sizes within this task due to cost. With the back piece as a plain weave structure, the prototype guarantees the simultaneous structural stability and flexibility to fit all body shapes and postures. The plain weave back piece with color contrast design also enables and makes easier a spatial coordinate system for positioning the actuators.

Introduction

As described in T 5.4 *Generation of "2D" of textile prototypes* from which D5.7 is an outcome, the focus here is to make textile prototypes that are not necessarily ready-made garments, but textile constructions made to be used for psychophysical studies. This deliverable is a step towards a full-fledged HIPI, Haptic Intelligent Personalized Interface, a goal of the project. The physical prototype being the deliverable is called "*Test device*" below. Here this refers to the textile part only, as actuators and control electronics are discussed elsewhere.

D5.7 aims to:

- contribute to the overall aim of investigating the possibilities to make textile (non-visual, non-audial) communicative devices
- contribute to a better understanding of human haptic sensitivity, for which psychophysical studies will be performed;
- contribute to making a textile garment that could incorporate the mimicking of haptic language signals on the back and shoulders.

Choice of modality

Based on the previous work (D5.5 and D 5.6) and discussions with other WPs (WP 3, WP6 and WP8), the modalities chosen are vibrotactile and thermal, for several reasons:
- vibrotactile is the most common modality after visual and audial channels;
- there are many small sized vibrotactile elements on the market suitable for integration in textiles;
- thermal is of interest in a general perspective relating to textile comfort in general and of particular relevance in products such as outdoor jackets with thermal heating cables, heating socks, cooling vests for sports etc.

The requirement for the *test device*

The *test device* should be supportive of the psychophysical experiments (for D6.3). The testing subjects for the study are anticipated to be normally scattered populations in terms of length, body weight, body shape/type, sex etc. It is not possible to make many different garment sizes within this task due to cost. Other requirements are listed in the table below:

Requirement for the *test device*:	**The solution:**
Enable actuation on the back, for both modalities	Tight fit garment
Studies on human capability on different body locations (on the back) of haptic signals should be possible	Tightly and firmly fit the entire back
Studies on human capability for spatial resolution of haptic signals should be possible	As many actuating points as possible
Studies on human capability for temporal resolution of haptic signals should be possible	Comfort for long-time wearing
Positioning of actuating elements on body locations should be easy	- easy to take on and take off - easy attaching on and off the actuating elements

Design and prototyping of the *test device*–the Plain Weave Vest

The primary function of clothing was to cover and protect the body. Today, people also use garment to improve their overall appearance and identify themselves with a sex, status, social class[1] etc. The use of smart materials and design also enables other functions, such as being waterproof and antibacterial. In this deliverable, the prototype garment is going to serve as a *test device* to support the psychophysical study; nevertheless, the primary requirement of the garment, i.e. comfort and fit should not be ignored. Statistics show that to cover 95 percent of the population, 11 sizes charts are needed[2]. Body posture and shape (see figure 1) impact on the design and garment fit significantly. Take an easy piece, the vest as an example, in order to make a perfectly fitting vest, the neck to chest height, neck to waist height, neck to hip height, chest circumferences of chest, waist and hip are essential parameters. From a garment design point of view, the one-size-fits-all solution only exists in T-shirt. A one-sized T-shirt can fit small sized population as an 'oversized' garment and fit the large sized population as 'tight' garment. In our study, to be able to actuate the back of each testing subject, the actuating elements should have good contact with the back of the testing subject. The one-sized T-shirt on a fit for a large man, say EU/DE 56, might have the majority of actuating elements hang loose and contactless when wearing by a Women EU/DE 36 sized person.

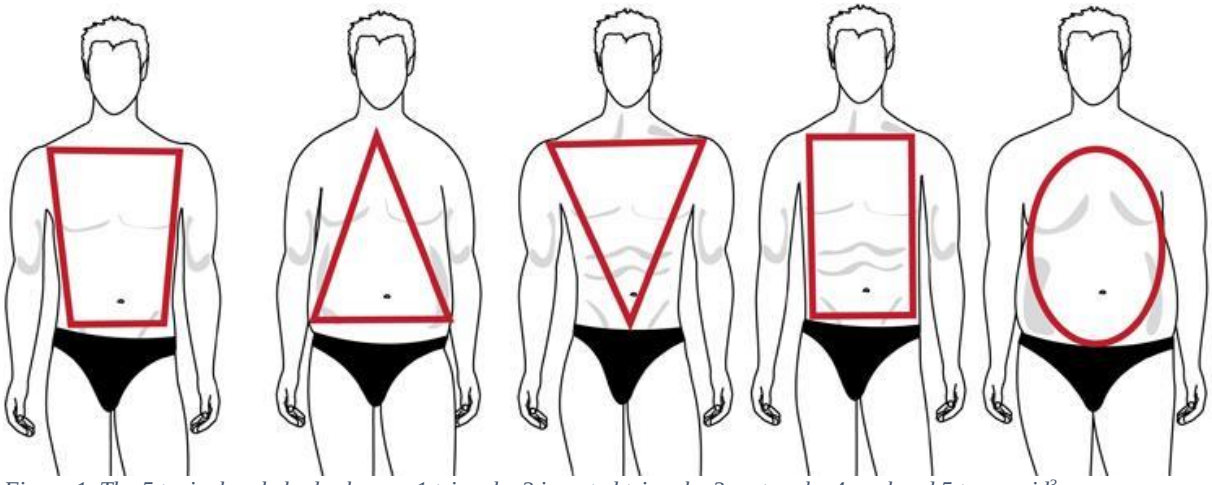


Figure 1. The 5 typical male body shapes: 1 triangle, 2 inverted triangle, 3 rectangle, 4 oval and 5 trapezoid[3].

a. Design for one-size-fits-all

Instead of using the standard garment design approach, we proposed an innovative solution to make a sequenced "sandwich-construction" by a number of straps placed from to lowest part of the back, up to the shoulder. The overall size of the prototype is adjusted by the buckles at both sides, while the straps are closed in front by Velcro. The individualized length adjustment and closing solution make the prototype fit all body shapes.

[1] Marina Alexander, Lenda Jo Connell, Ann Beth Presley, (2005) "Clothing fit preferences of young female adult consumers", International Journal of Clothing Science and Technology, Vol. 17 Issue: 1, pp.52-64

[2] D. Gupta, B.R. Gangadhar, (2004) "A statistical model for developing body size charts for garments", International Journal of Clothing Science and Technology, Vol. 16 Issue: 5, pp.458-469,

[3] https://www.realmenrealstyle.com/dress-body-shape-guide/

Figure 2. The one-size-fits-all concept by using a number of horizontal straps covering the back, and the adjusting buckles.

b. Actuating element integration

A matrix solution is proposed for the integration of actuating elements. A plain weave structure is created for the back, the introduction also of vertical straps improves the mechanical stability of the back panel. In total, a matrix of 168 positions is formed where actuators could be placed. A coordination system of the matrix is suggested in figure 3, left.

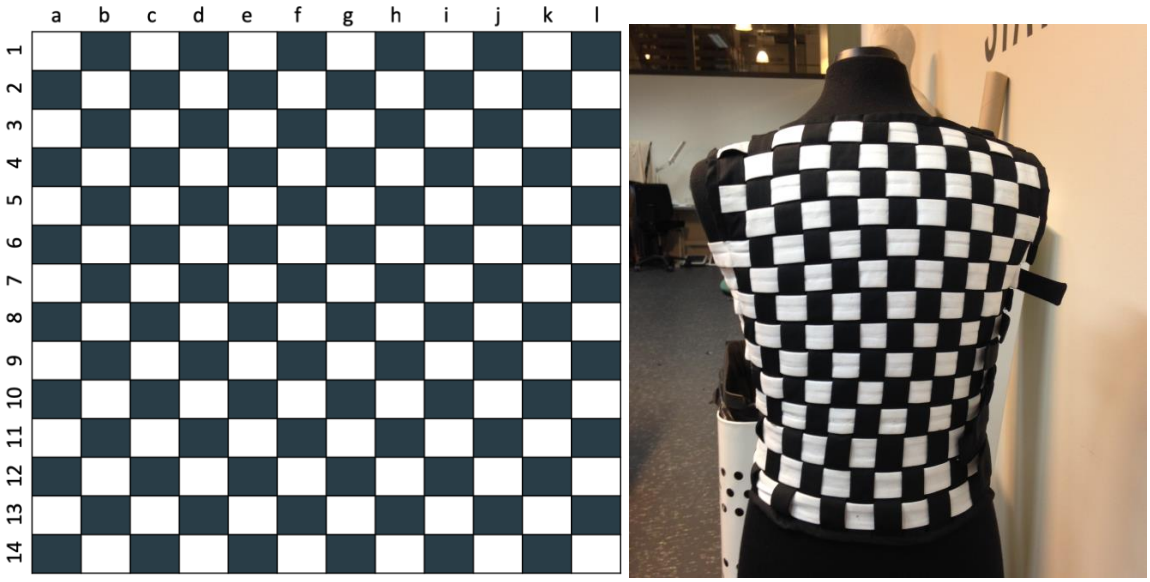


Figure 3. The matrix and the back side view of the Test device.

Twelve pockets were produced as the carriers for the actuators. The pockets can be placed at any of the positions inside of the back piece, (see fig 4).The pockets for the actuators can be

placed either before putting on the vest or when it is being worn by a person. The placement of the pockets can be found in Appendix 1: The User Manual.

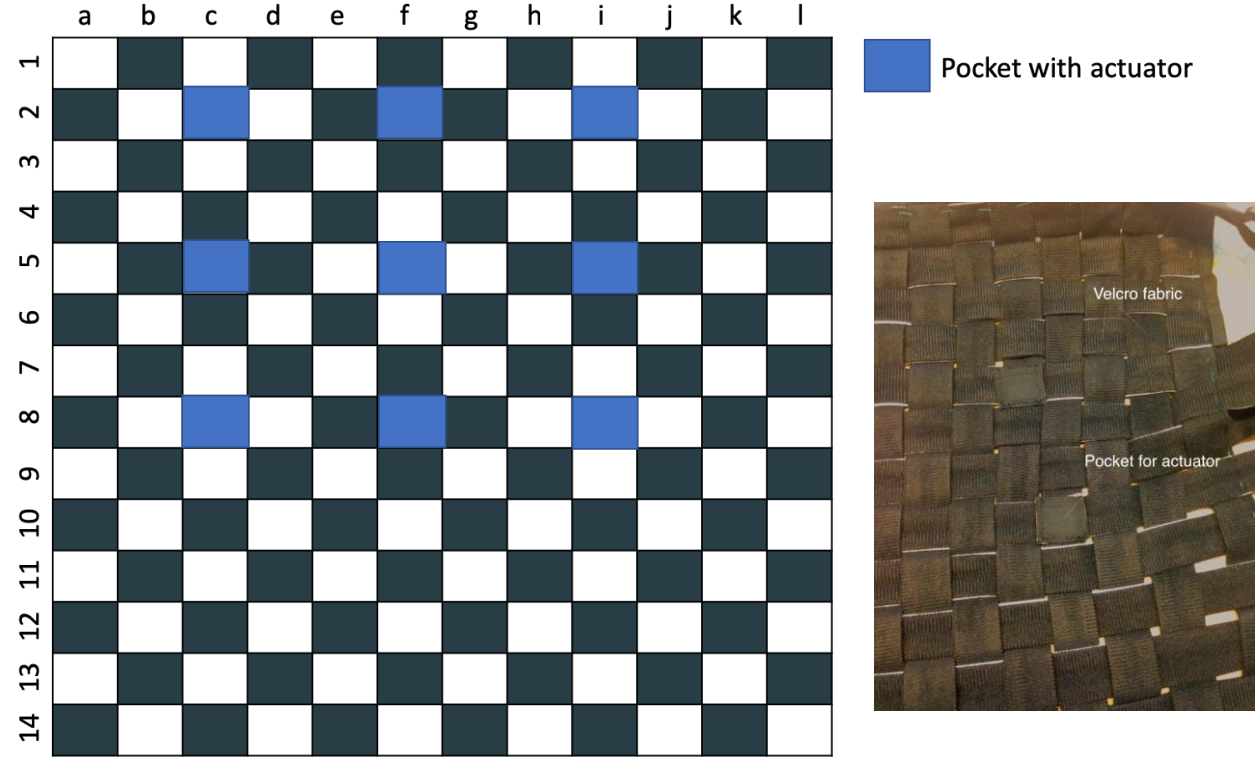


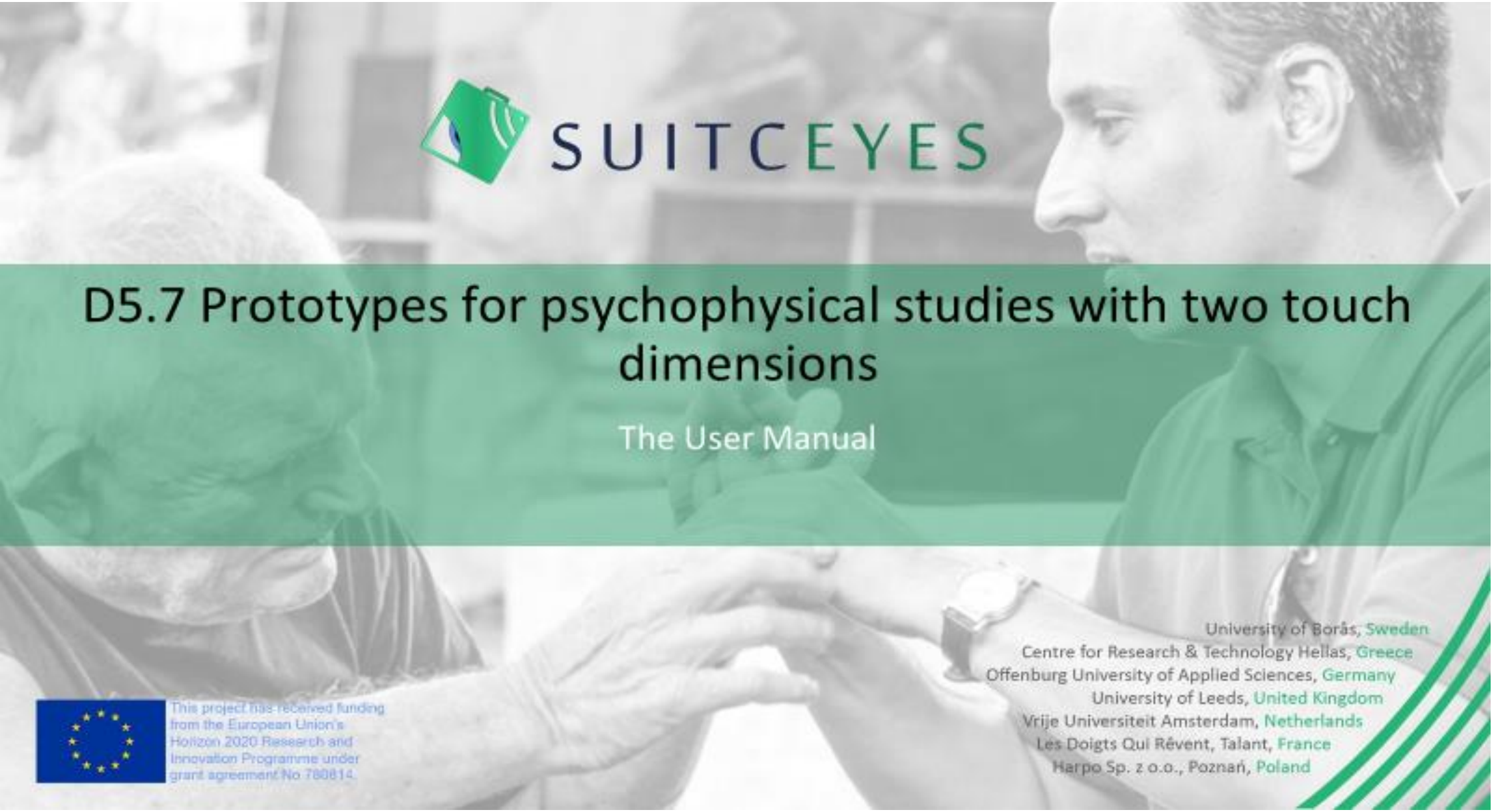
Figure 4. The pockets with actuators should be placed inside of back piece

Conclusion

The plain weave vest serves as the test device for conducting the psychophysical studies. At this stage, it is not possible to make many different garment sizes within this task due to cost. Thus, a one-size-fits-all solution is proposed. The prototype not only functions as a passive (rigid plastic) 'motherboard' for hosting the electronics (e.g. sensors and actuators), with the plain weaving structure at the back side, the prototype also guarantees structural stability, while also offering the flexibility to fit all body shapes and postures.

Appendix 1: The User Manual

The user manual below is intended to guide the psychophysics studies in WP6.



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D5.7 Prototypes for psychophysical studies with two touch dimensions

The User Manual

University of Borås, Sweden
Centre for Research & Technology Hellas, Greece
Offenburg University of Applied Sciences, Germany
University of Leeds, United Kingdom
Vrije Universiteit Amsterdam, Netherlands
Les Doigts Qui Rêvent, Talant, France
Harpo Sp. z o.o., Poznań, Poland

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 780814.

Test Device- the plain weave vest

FRONT

BACK

In total 12 pockets included

Size adjustment buckles

pocket for the data process unit

pocket for actuator

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Unpacking

1. Unfold the vest from the box

2. Open front of vest, 10 crosswise straps

3. You will find 12 pockets attached to the inside of the back.

These can be removed before putting the vest on.

4. You also will find a roll of Velcro. If the pockets are too small for the actuators, you can cut the Velcro to any size and tape it onto the actuators.

SUITCEYES

Putting on the vest

1. Put on the vest

2. Adjust the **shoulder buckles** (on both sides) to fit the height of the testing subject.

SUITCEYES

Putting on the vest

3. Close the vest and adjust the width with the crosswise straps so the fit is tight across the body.

Tips: first close the top and bottom crosswise straps, then the the ones in between.

4. If necessary, further adjustments to tighten or loosen the width can be made with the buckles on the right side.

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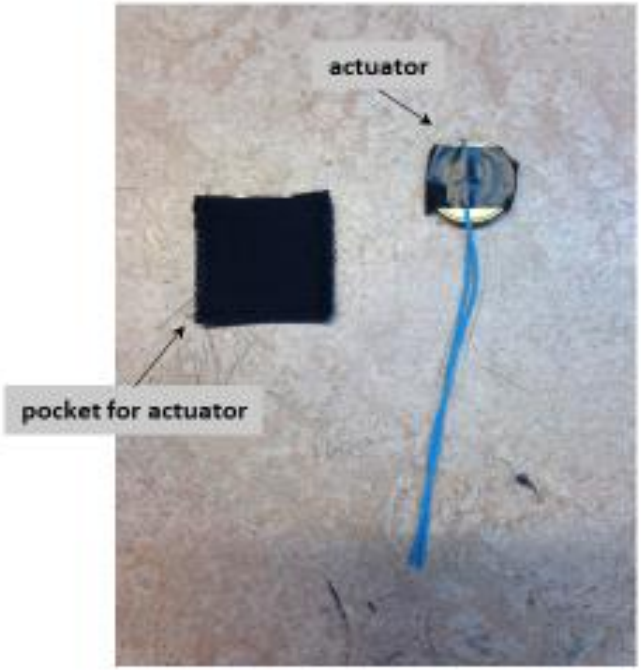
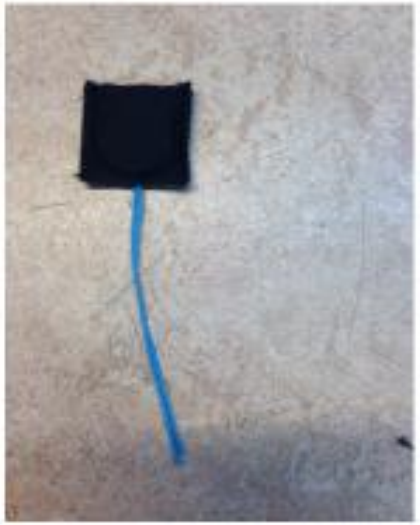
5

Preparing the actuators

Pull the cord of the actuator through the opening in the bottom of the pocket; place actuator in pocket.





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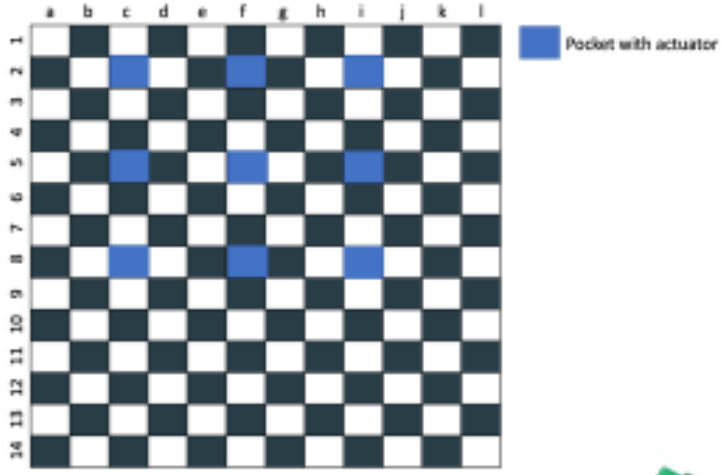
Placement of actuators

Placement of actuators can be done in two different ways:

a). before the vest is put on, if you know exactly where the actuators should be positioned
b). after the vest is put on, if you need to try different positions.

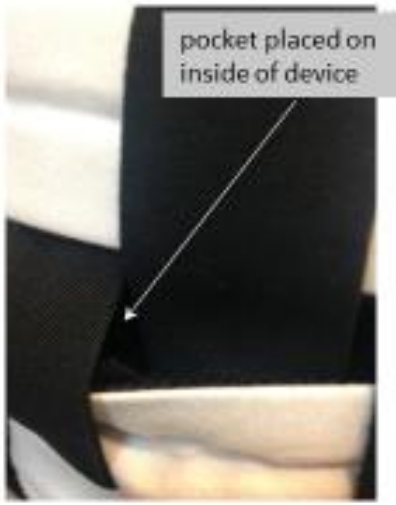
a). Attaching actuators before putting on the vest: place pockets on the inside of the back piece of the vest, with velcro pieces facing towards each other and actuating elements towards the body



SUITCEYES

Placement of actuators

b). placing the actuators after putting on the vest: place the pocket under two crossing straps on the back piece.



Pull the cord out

Please check the link below or scan the QR code to see a video clip on how to place the pockets after putting on the vest:

https://youtu.be/zjtwTciLu-Y

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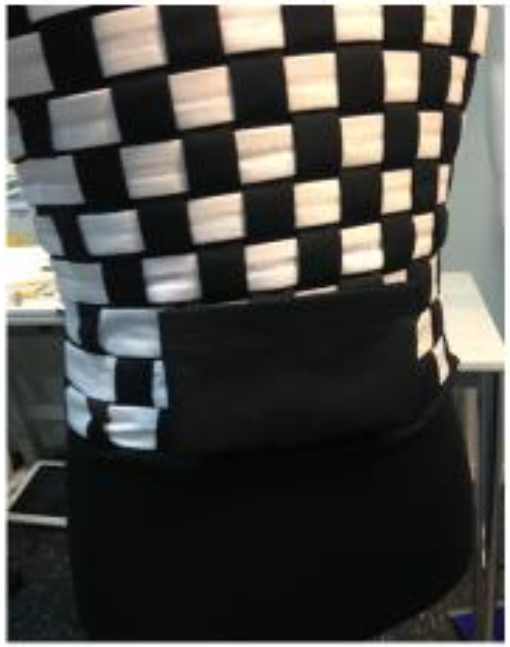
Pocket for the data processing unit/power source (optional)

The pocket can be placed anywhere on the back piece

Place pocket where suitable

Close pocket with the velcro



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