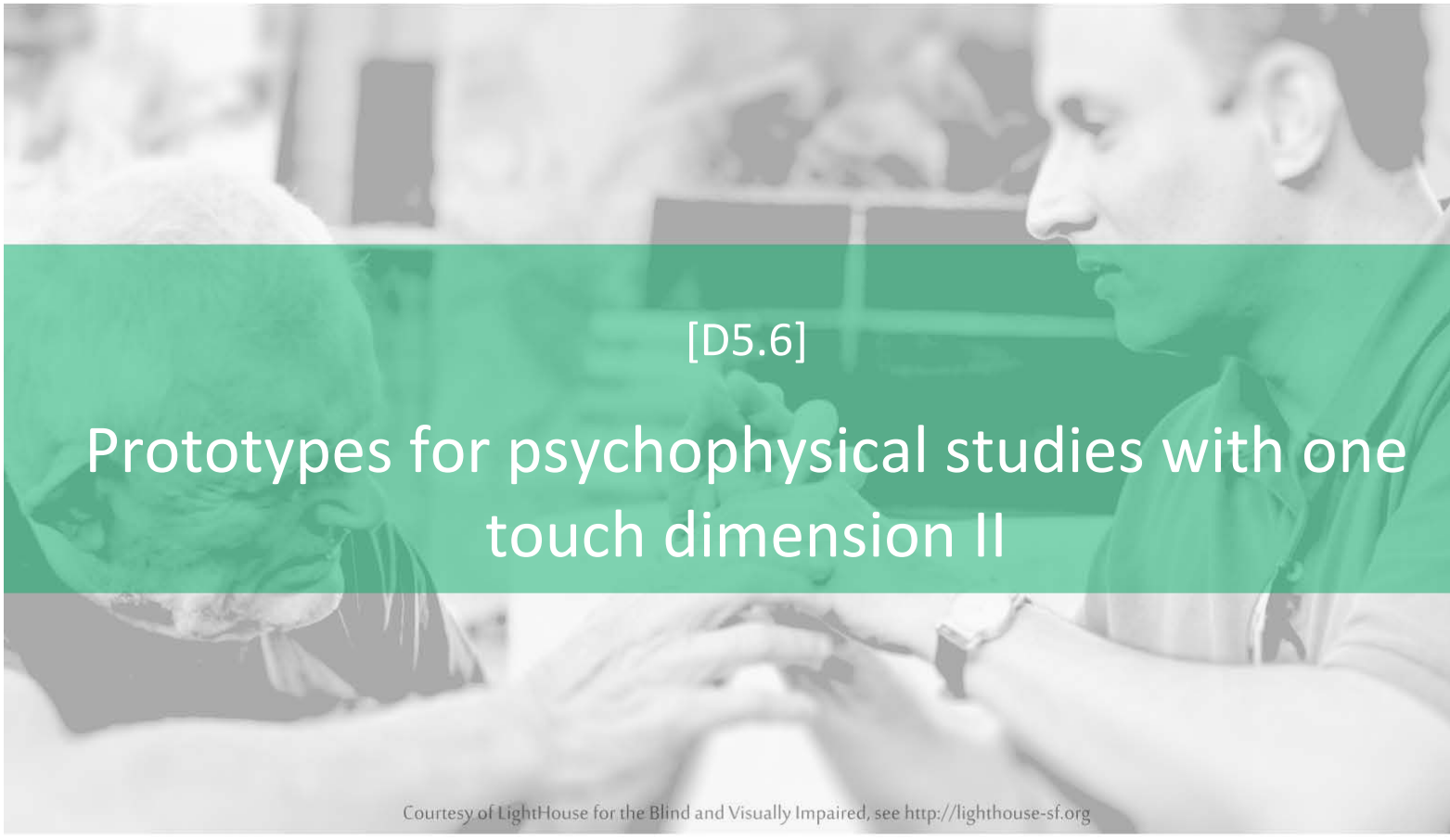
SUITCEYES

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



[D5.6]

Prototypes for psychophysical studies with one touch dimension II

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	5.6
Part of WP	5
Lead organisation	HB
Lead member	Nils-Krister Persson

Revision History			
V#	**Date**	**Description / Reason of change**	**Author / Org.**
v0.1	May 11 2018	Structure proposal	Li Guo/HB
v0.2	July 13 2018	First draft for internal review	Li Guo/HB
v0.3	Aug 24 2018	Second draft addressing review comments submitted to HB	Li Guo, Nils-Krister Persson/HB
v0.4	Aug 27 2018	Final draft after PC's comments	Li Guo, Nils-Krister Persson/HB
v1.0	Aug 29 2018	Final draft submitted to the EU	Li Guo, Nils-Krister Persson/HB

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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
Arduino	The Arduino is a suit of programmable control units for electronics common in smart textile development.
Arduino Uno	The Arduino is a suit of programmable control units for electronics common in smart textile development. Uno is one type within this suit.
DFRobot	DFRobot is a provider of do-it-yourself electronics
GND	On the Arduino board there are a number of connections (“pins”). GND is one of the three, corresponding to the electrical ground.
Knitting	One of the most important fabric forming processes together with weaving creating fabrics with loops thereby enabling elasticity
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.
PIR	PIR is an example of sensor that could be added in the future, standing for passive infrared sensor.
VBM	Vibration module
VCC	On the Arduino board there are a number of connections (“pins”). Vcc is one of the three used, having a high (some V) voltage.
WPx	Work package (1 to 8)

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Summary:

The deliverable *5.6 Prototypes for psychophysical studies with one dimension II* is focused on developing prototypes. This is a short documentation thereof.

The theme is integration of vibrotactile actuators. Vibration is the most used haptic mode. It is therefore relevant to look at how this technology can fit into the context of the SUITCEYES project.

Textile elastic band and the first version of a complete garment, a dress, are designed, manufactured, modified and tested. Both were designed with flexibility in mind enabling psychophysical testing on different body locations and using a varying number of vibrators.
A vibration module (VBM) from DFRobot was used having the size of a coin and therefore compatible with textile integration and maintained comfort.

The prototypes are to be used for further psychophysical measurement as well as garment development within the SUITCEYES project. Lessons learnt are that the production of this garment is compatible with textile processes and flow already existing; size fitting, patterning, grading, sewing; and also that comfort could be obtained after integration of vibrators. Still currently available batteries, if any, might be heavy for a fully portable solution. Finally, it is clearly possible to create attractive, even fashionable garments, also for our purposes and our target group.

Choice of modality

The modality chosen for this iteration is vibration. Vibration is the most used haptic communication mode, found in cell phones as well as assistive devices. It is therefore relevant to look at how this technology can fit into the context of SUITCEYES. This is done here.

A vibration module from DFRobot is chosen for the first iteration, described here. The vibration module (VBM) uses a vibration motor as its vibration source. Vibration is created by a set of adjustable weighted blocks attached to the end of rotating shaft. The centrifugal force generated by high speed rotation of the shaft and weighted blocks creates vibration. This vibration module is in the size of coin (ϕ = ca 8mm), the flat surface design makes it possible to integrate into textiles using taping and sewing. This module can be connected to an Arduino board using 3 pin interfaces (control signal input, VCC and GND). The Arduino is a suit of programmable control units for electronics common in smart textile development.

Test 1: controlling vibrators using a motion sensor and a push button

Using the Arduino system, a program was developed as follows:
In the first iteration, a push button and a motion sensor were used as controllers connected to Arduino Uno. Other types of sensors, such as light sensor, flame sensor, PIR (passive infrared) sensor, temperature sensors and rotation sensor are also available for testing.

The first iteration of controller has been designed to evaluate:

1. If the VBM can be controlled by push button and the motion sensor.
2. The duration and intensity of the VBM.

In detail the following code was used:

Hardware connection:

Motion Sensor -> Digital pin 2
Push button -> Digital pin 8
VBM 1 -> digital output pin 11
VBM 2 -> analog output pin 3 (PWM, Max 255)

Coding:

```
byte sensorPin = 2;
byte indicator = 13;
const int buttonPin=8;
const int VibPin1= 11;
const int VibPin2= 3;
```

```
int key= 0;

void setup()
{
      pinMode(sensorPin,INPUT);
      pinMode(buttonPin, INPUT);
      pinMode(VibPin1,OUTPUT);
      pinMode(VibPin2, OUTPUT);
      Serial.begin(9600);
}

void loop()
{
  key=digitalRead (buttonPin);
  if (key==HIGH)
      {
      analogWrite(VibPin2, 255);
      delay (2000);
      analogWrite (VibPin2, 122);
      delay (5000);
      digitalWrite (VibPin2, LOW);
       }
  byte state = digitalRead(sensorPin);
  digitalWrite(VibPin1,state);
  if(state == 1)Serial.println("Somebody is in this area!");
  else if(state == 0)Serial.println("No one!");
  delay(500);
}
```

Translated this means: Press the push button, VBM 2 vibrates for 2 seconds at maximum intensity (PWM=255) and then 5 seconds at half of intensity (PWM=122).
When someone (or something) gets into the motion sensor's detection area, VBM 1 turns on at maximum intensity (PWM=255). Serial monitoring shows 'Someone is in this area'.

The textile prototypes

Flexibility was searched for. Different body locations, different sizes, different number of VBMs, different types of VBMs was to be possible to handle. Therefore, a band/strap was constructed as well as a first version of a garment approaching a full- fledged product.

A: Textile band

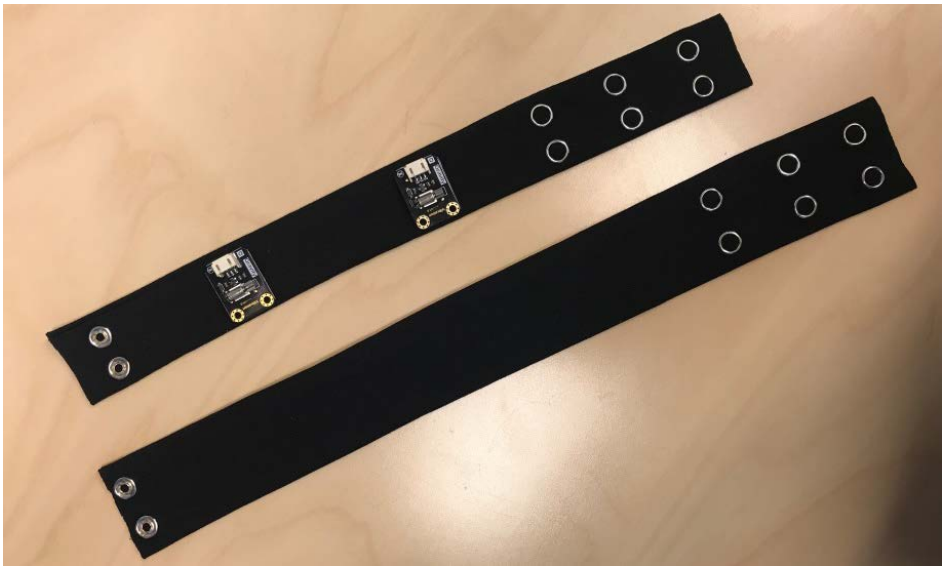

Figure 1: Textile band in female size with VBMs and textile band in male size.

Two textile bands, one female size and one male size were developed for testing the VBM that can be attached to limbs (both upper and lower). In this iteration, the VBMs were fixed on to the textile bands with double faced adhesive tapes, which allows the maximum flexibility in terms of position and reposition.

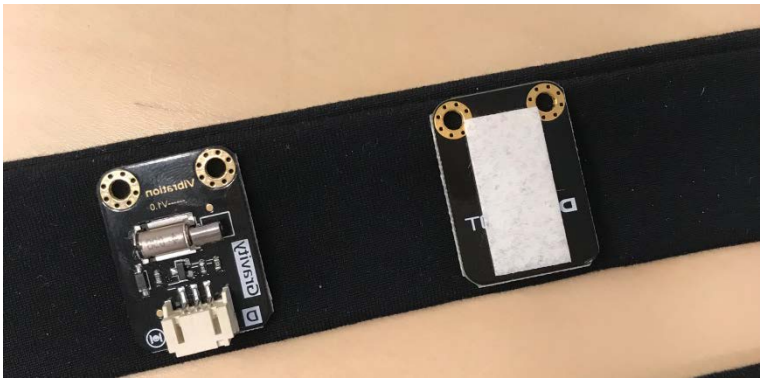

Figure 2: The front size of VBM and the back size of VBM with adhesive tape.

In summary it is shown possible to make these textile prototypes for further psychophysical investigations.

B: First version of 'The Red Dress'

The SUITCEYES project is to develop a useful item for haptic communication. Already in the proposal a red dress was used to illustrate the concept. Here we present the first version of this.

The aim is to create a garment that can be used as a test bed for evaluation of vibrotactile communication on (to start with) upper body area. Based on the literature review done by Astrid M.L. Kappers (June 7, 2018) as part of WP6 activities, back, shoulder and upper arm were chosen as locations for VBMs as they are the most common places used for vibrotactile threshold measurements and vibrotactile spatial discrimination testing. The idea is that a large number of VBMs can be easily attached to the garment at almost any location.

A bodycon (figure 3, left) dress was designed as certain tightness improves the sensation of vibration. A belt was used for hosting the Arduino board and the battery pack. The belt (figure 3, right) is detachable, so that the dress is fully washable.

Figure 3: the red dress (left) and close look of the belt (right).

In order to achieve maximum flexibility of positioning the VBMs, Velcro stripes were attached onto the back side, front side and both sleeves of the dress (figure 4). Figure 4, left also illustrate how the VBMs can be attached to the dress.

Figure 4: Velcro on back side (left), front side (middle) and sleeve (right) of the dress.

In later version it might be that Velcro stripes are to be placed not on the outer side but on the inner, i.e. a lining. Also, the very position and what locations those are relevant will be assessed. Tightness towards the body is also presumed to be important for future versions.