Figure 1: Final version of the watch

Bondwatch: Fidgeting Watch for Long-Distance Relationships

Annetta Sillard,
annetta@kth.se

Jason Hsuan Li Huang,
hlhu@kth.se

Leonardo Rignanese,
lrig@kth.se

Abstract
This pictorial explores how fidgeting can be used as a way to communicate with loved ones at a distance. Texting or speaking over the phone only allows for a limited understanding of each other's emotional state. Wearable interactive objects that register the fidgeting behaviour of the person wearing it could offer a new dimension of expressing one's mood to a partner or friend. In order to explore this space, we designed a pair of wearable smart watches that captured explicit fidgeting behaviour and communicated that through colors to the other device. The project was done through a first-person perspective, where we would create, test and reflect on the device's design.

Author Keywords
Fidgeting, long-distance relationship, remote interaction, wearable

Figure 2: Photo of Lovebox Original Color & Photo, via Lovebox. (https://eu.lovebox.love/products/lovebox-color-photo).

Figure 3: Photo of Long Distance Friendship Lamp, via Uncommon Goods. (https://www.uncommongoods.com/product/long-distance-friendship-lamp-wood).

Introduction

In today's world traveling is fast and convenient and the Internet has made people connect in new different ways. Distance is not a big problem anymore. From calls to chatting and video calls, new ways of communicating are quickly being developed. Wearables offer the possibility to have ubiquitous technology on our body allowing us to always access the Internet and being reached by information. The wearable market is in fact growing steeply [1]. In this project, we focused on wearables as medium through which people in long distance relationships could feel closer. Our idea is to use fidgeting as a way to understand and express emotions between partners that are physically far from each other.

Background

Fidgeting

Fidgeting is defined as using body parts or items as nonessential manipulation or engaging act to the central ongoing events or tasks [2]. Some of them make people focus, some others are creativity boosts [3]. Some fidgets are popular in social contexts such as doing certain trick with a pen in our hand in order to be part of a group, while other fidgeting items are more intimate and sentimental, like wedding bands that can remind people of their partner [4]. However, researches demonstrate that it is unlikely that direct mapping exists between particular objects or interactions and particular experiential states. Often they are just reminders of working rhythms or habits and work in strict relation with their internal flow and mental state [4].

Remote Presence

Connecting people that are physically distanced has been explored in previous projects. Remote presence has been explored through a special bench that allows the sitter to feel the warmth of a stranger sitting on a partnering bench [5]. Communication through touch between physically distanced people has been explored through paired devices that mirror the interaction, as if both people are interacting with the same object [6].

Existing Products

Before starting, we analysed previously developed products and ideas. We discovered that many devices have been developed to allow couples to remotely touch, feel, hug and even kiss [7]. However, the most interesting ones related to our project are:

- *Lovebox* [8] (Fig. 2) is a wooden box that contains a display. The partner can send a message to the Lovebox and a hearth put in the exterior of the box will spin as a notification; the lid then can be opened and the message will be displayed.
- *Long Distance Friendship Lamp* [9] (Fig. 3) is a set of two lamps that can change color when the partner touches it.
- *Long Distance Touch Bracelet* [10] is a set of two wristbands that are used to send each other vibrations based on the touch.
- A touchscreen pen [11] that adds emotion to an SMS, depending on how the user interacts with the pen.
- Jewelry can also be smart devices, with the difference that they are crafted. People tend to add a lot of sentimental value to jewelry, but perhaps less to their gadgets [12]. The main difference is the design of the artefact, the chosen materials and our associations with the materials.

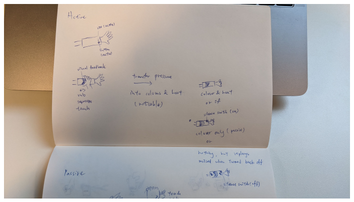

Figure 4: First sketch of active interaction.

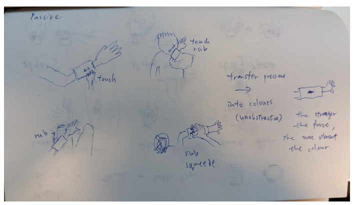

Figure 5: First sketch of passive interaction.

- *Yo-Yo Machines* [13] are devices for interactive communication that allow users to express themselves to loved ones through non-verbal signals, like light, sound and movements.

Approach

Our concept discovery started initially with some research on existing products or studies, and a team brainstorming where each one of us proposed an idea. We noticed a common interest in working with devices that would help people stay connected in long-distance relationships. We came up with three different concepts and used the Six Thinking Hats method [14] to evaluate what was the most convenient one based on utility, time and knowledge needed to build it. After getting some more detailed thoughts, we decided that the most interesting way of interaction and fidgeting for our scenario was to use buttons and pressure that translates emotions into visual signals. Subsequently, we narrowed down the usage scenario and target users, along with other important factors and interactions, and we defined our concept: we wanted to make a wearable used by romantic relationships in a 1 to 1 usage scenario, focused on shared signals useful to acknowledge each other. A wearable device would minimize the risk of having an extra device that could easily be forgotten somewhere. The idea was that fidgeting input would be transformed into an output that indicates some emotional states of the partner (stressed, relaxed, excited, etc). The initial idea was to make a simple wristband but due to the dimension of the battery, controller and wires, we opted to create a watch where all the components could be hidden in the watch case. The idea of making it into a watch also gave the device another purpose, giving the user a reason to wear it even if the partner forgets to wear it. Watches can also be seen as an element to express personal style, so the user could already be used to wearing watches.

Activities

In order to develop the device, we went through different steps that helped us to narrow down the concept and create a more meaningful design.

Sketching

At first, we created some sketches on paper (Fig. 4, 5) and thought about more direct or even obstructive ways to support intimacy as well but found it to be contradictory to the concept of fidgeting. Yet, we listed some important ways of interactions that fit our direction, such as touch, tap, and pressing as the device inputs or ways to fidget, and colour, shape, material, and heat as outputs. We wanted to carefully analyse how a potential user could interact with the wearable and how the recipient would receive the output. We noticed that both sides offer interesting approaches to input and output data actively or passively. For example, the device could read data from a button (active input) that can be turned into a color in the recipient's device (passive output), or it could turn the movements of the arm/wrist (passive input) into a vibration (active output), or a combination or merge of these methods. After an analysis of the benefits and threats of each of the potential active or passive input and output, we decided to make a wearable that will read two active inputs (pressing and stroking) and change color on the other side (passive output). We created a visual concept of the watch (Fig. 6) that shows the design and shape of the ideal final product.

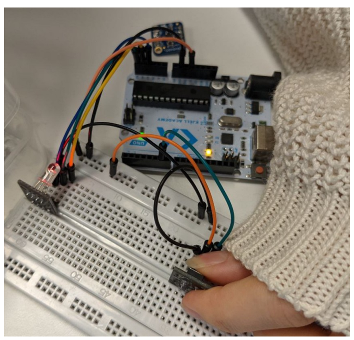

Figure 7: LED turning red after several clicks on the button.

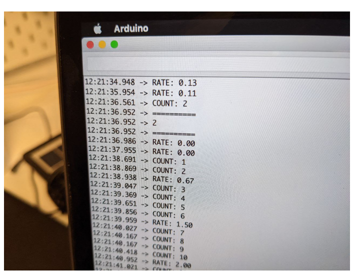

Figure 8: Arduino serial print.

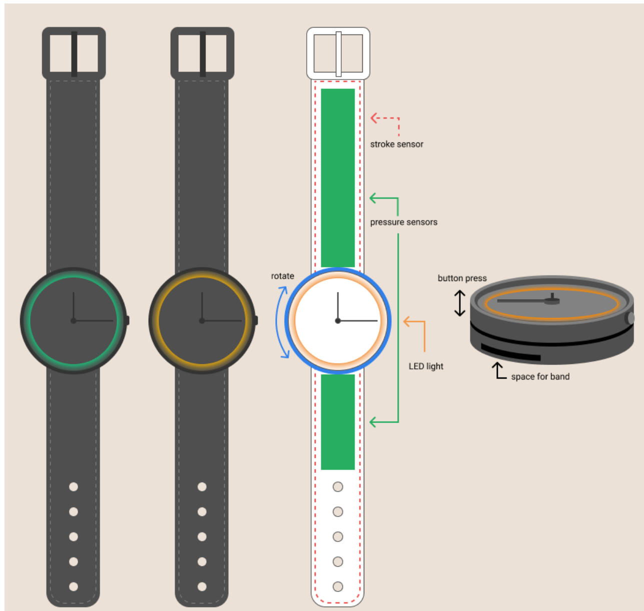

Figure 6: First visual concept.

Prototyping

Once we confirmed our idea to make a wristwatch with fidgeting components that translate fidgeting behaviour like pressing into emotions or state of mind into colors, we made the first prototype. We were inspired by previous work where colors were used as a way to communicate certain emotional states [11]. We wanted to explore colors for a similar purpose and the most accessible way for us to work with color-shifting outputs were LED lights. We used Arduino and started with a button and an LED: whenever the button was pressed expeditiously, the light had to change from green to red indicating a feeling of stress (Fig. 7). On the Arduino's serial print, we could see the instant rate of the clicks on the button and debug the code (Fig. 8).

Once the button and the LED were configured, we focused on the next fidget element of the device: the wristband with a pressure sensor. We used two pieces of conductive textiles and a piece of Velostat to be placed in between them (Fig. 17, 18, 19). The idea was to quantify the pressure on the band thanks to Velostat that changes resistance when it is pressed. We made three version of the band before reaching a reliable result. Once the sensors were all ready, we had to imagine how to put everything together and we made a paper mock-up with real size components (Fig. 9).

Figure 9: Mock-up of the watch and its components.

Real-life Testing

We simulated to have the watch on the wrist in our daily life and imagined what it would be to have a device that can communicate our feeling to the partner. Leonardo wrapped some pieces of paper around his watch's bands and kept them on his wrist for 24 hours to understand the real dynamics of such a device. The first thought has been about the design: a device that is always at your

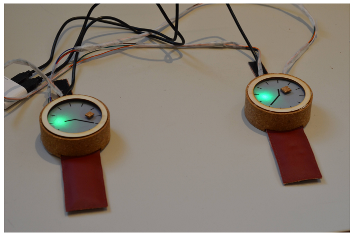

Figure 10: Two watches connected together to simulate the use case scenario.

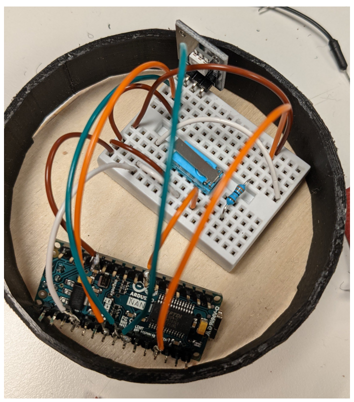

Figure 11: Components inside the case.

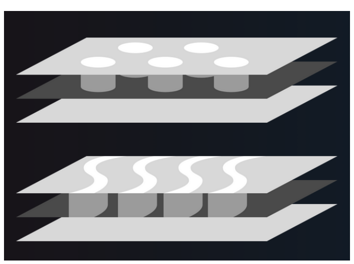

Figure 12: Foam patterns inside the band.

wrist needs special attention regarding materials and shapes. This point was confirmed when Leonardo met some friends who soon noticed the "new" watch. Another issue was the constant awareness of the watch on the wrist: checking the change of light of the watch case (which would correspond to a message from the partner) became a bit disturbing after a while. Moreover, the fact that the device is always reading your movements and touching while sending light messages to your partner, made Leonardo feel sensitive on his arm movements. If the device is not perfectly calibrated, it could read wrong movements and send wrong messages. However, the high-awareness feeling passed away once he got used to the new device or simply when he got distracted. The conclusion of this real-life testing and the solution to these problems could be an on/off switch or a way to make the device download the data from the partner only in certain moments. Moreover, a heartbeat sensor may be useful to eliminate wrong messages (for example, send a calm signal when the person is agitated).

Finalizing

After setting up the prototype with Arduino UNO and the two sensors, we started to build the final prototype for demonstration. At first, we transferred the code to Arduino Nano and based on that set the size of our final device (Fig. 11). We then used wood for the main material of the casing for better aesthetic and feeling, and 3D printed hollow cylinders for the rounded structure with a layer of cork on the outside to balance between the durability of the structure and visual appearance (Fig. 13). Afterwards, we sewed two pieces of leather together with the conductive textiles and Velostat and a layer of foam with patterns (Fig. 12). We then inserted the LED from one device to the other, and hence simulated two devices connected with each other (Fig. 10). We added a piece of acrylics as the watch face with a printed picture of the watch display underneath. The acrylic allowed the LED light to shine through while hiding all the electronics. The watch face could be pressed down gently to click the button which is hidden underneath. The most difficult part was soldering on a small device in a precise manner, which also made putting everything together an uneasy task with careful handling. In the end, the devices worked properly and were less fragile than expected. However, the pressure sensor wristband could have been improved with different patterns in the foam for a more responsive result.

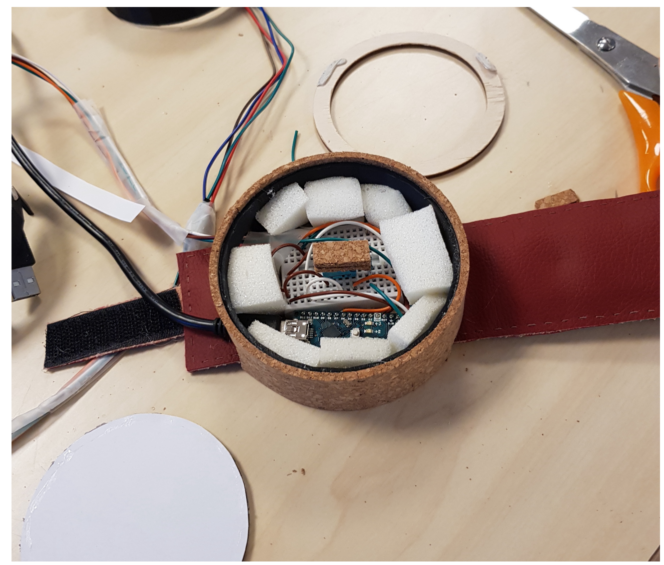

Figure 13: Final version without the watch face.

Design Concept

The design is made of three main components: the watch itself, a hidden button in the watch case that sense whether someone is more stressed or relaxed, and a

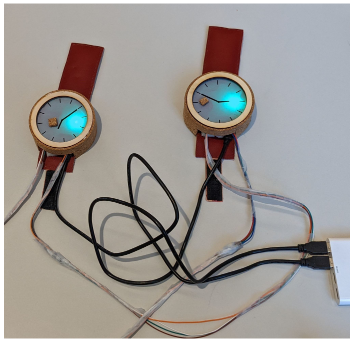

Figure 14: Final version with wires.

comfort cloth with a pressure sensor made of conductive fabric for stroking that indicates if someone is satisfied or not.

The Watch Shape

Our idea supports fidgeting as a passive action of communication and acknowledgement, yet uses lights as the background colour for intuitive and instant understandings when looking at the time on the watch. The design (Fig. 15) is made to hide all the electronic components of the prototype (Fig. 13). In this first version we could not hire the wires due to the short time, therefore we created a double sized watch with only one band (Fig. 14).

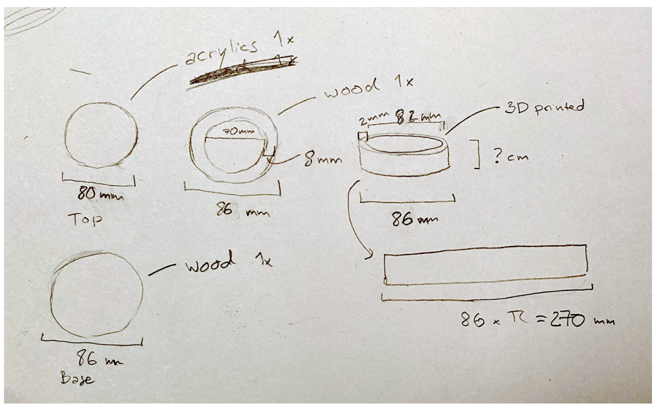

Figure 15: Design of the watch case.

The Hidden Button

The button is used as a fidget. It makes a nice sound and it returns pleasant haptic feedback when being pushed. It is used to read feelings as stress since we thought users that are stressed would press it aggressively. The button is hidden under the watch face in order to not be confused with the buttons used to set the time or change the watch settings (Fig. 13).

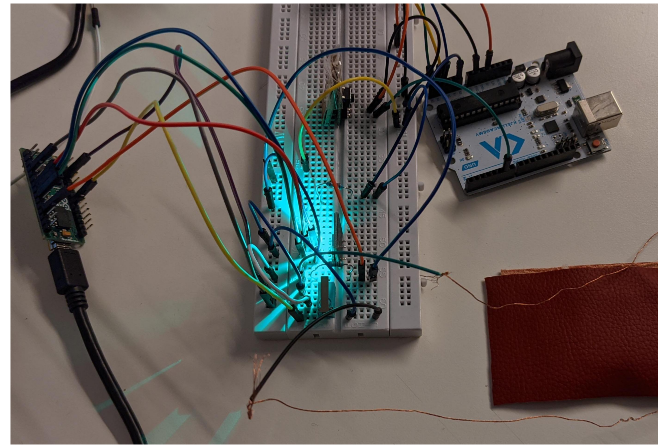

Figure 16: The final circuit.

The Stroking Band

The watch-band (Fig. 17) had the purpose to read stroking movements and understand when a person is relaxed or satisfied. It was made with two layers of conductive material and one layer of Velostat that works as a pressure sensor since its resistance changes whenever it is pressed. We made three version of it to reach a reliable sensor. The really first version (Fig. 17) consisted in two wires attached to two pieces of conductive fabric with a layer of Velostat between them. The values were reliable although the sensitivity on the pressure was low. The wires also were easily dislocated and made the whole sensor fragile. In the second version (Fig. 18) we used conductive strings instead of the wires and we sewed it in a S shape to the conductive fabrics. We kept the Velostat in the middle but it resulted to be too conductive and the difference between the pressed state and the idle state was not too evident. The third and final version (Fig. 19) had a piece of patterned foam (Fig. 12) to separate two parts of Velostat and provided more reliable values.

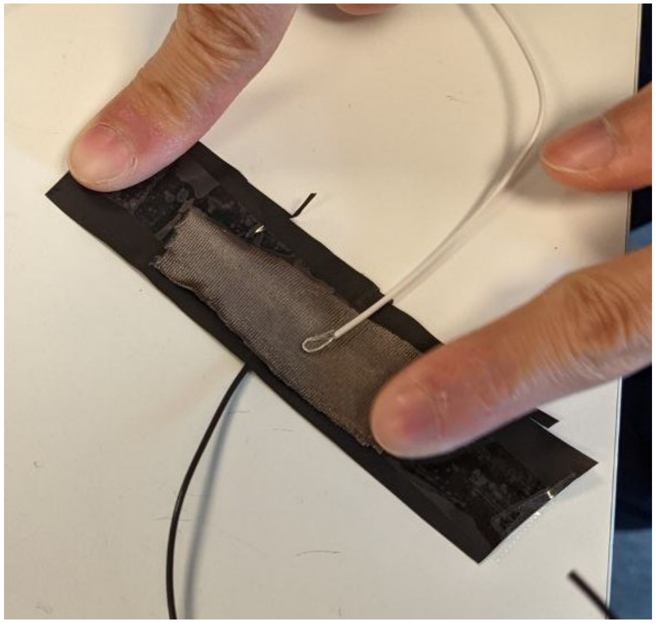

Figure 17: Building the first version of the watchband.

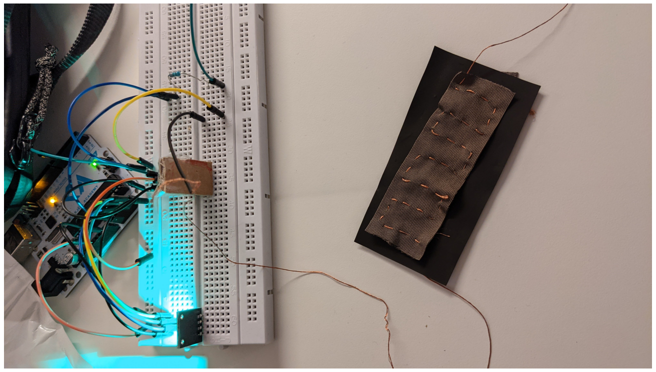

Figure 18: Building the second version of the watchband.

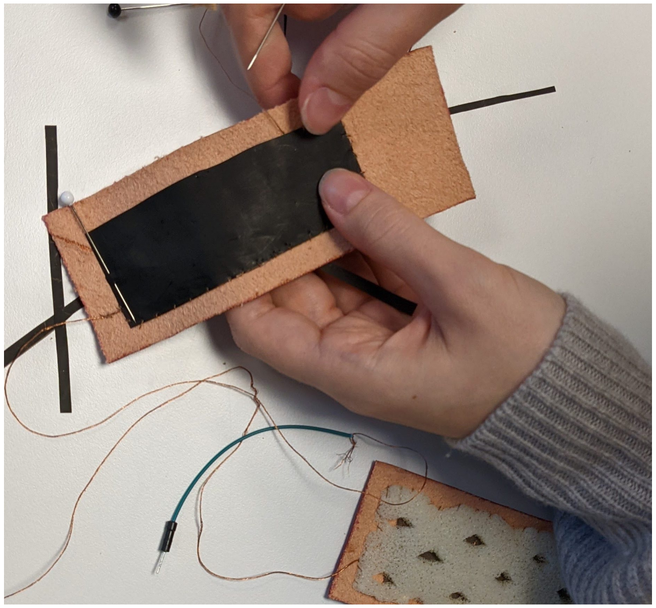

Figure 19: Building the third version of the watchband.

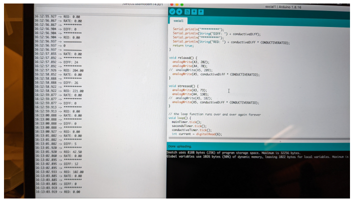

Figure 20: Arduino's serial prints indicating the click rate.

Analysis/Discussion

Map Fidgeting and Emotion

Mapping emotions to colors is hard and mapping fidgeting to colors is even harder. Our prototype aims to read emotional states from one user and send them to the partner as a change of color (Fig. 21) [11]. We found really challenging to map the input and return an accurate and meaningful output. What is the right threshold for the button clicks that indicates that a person is stressed? After how many strokes on the watchband you can say the person is relaxed? We used an experimental approach and set a threshold of 15 clicks every 15 seconds to switch the color from green to blue and a particular value of resistance on the stroking band (different for each of them, since the homemade bands do not have the same level of resistance) to say that a person is relaxed. However, a real test could provide more accurate numbers and the introduction of new sensors such as the heartbeat sensor might give us other data to better understand the feelings.

It would also be also interesting to discover through user testing on people in long-distance relationships, how they would actually use the device. Because we ourselves found the mapping of colors to an emotion not very easy to learn, there might be a possibility that users define their own meaning of different colors, as has been done in other products like the Yo-Yo machines [13].

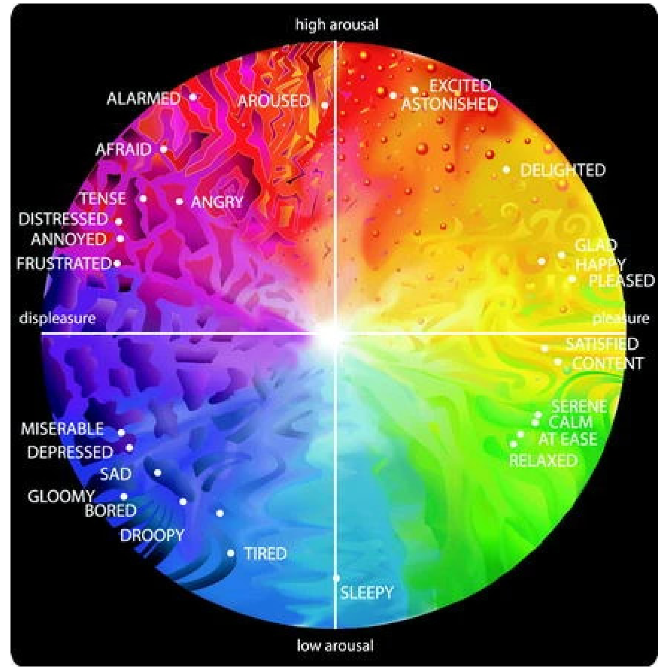

Figure 21: How colors represent emotions [11].

Portability and Design

The current design of the device does not allow for users to be in different physical locations, because the devices are physically connected through wires (Fig. 14). This means that an important aspect of the interaction could not be thoroughly tested with the devices in its current form. Another iteration should be done, where the devices would be wireless and powered by a battery and not connected to each other. Moreover, the smallest micro-controller we could get in the lab was Arduino Nano which measures 45 x 18 mm. In order to make a small and real-sized watch, we would need a dedicated micro-controller as small as possible. In such a way, we could focus on more premium materials and release a version that is nice looking and portable.

Conclusion

Considering the short time (about 5 weeks) we had to imagine, design and realize the prototype of the device, we are really satisfied with the outcome. Developing this device has allowed us to explore different materials for physical interactions and expend our knowledge about the field. Our idea was to explore how fidgeting could be used as way to communicate with a loved one and this device has explored that space. More iterations on the design and user testing would help to further understand how colors and fidgeting could be used for this purpose. Finally, this device opens possibilities in the field of indirect emotions communication between people at a distance.

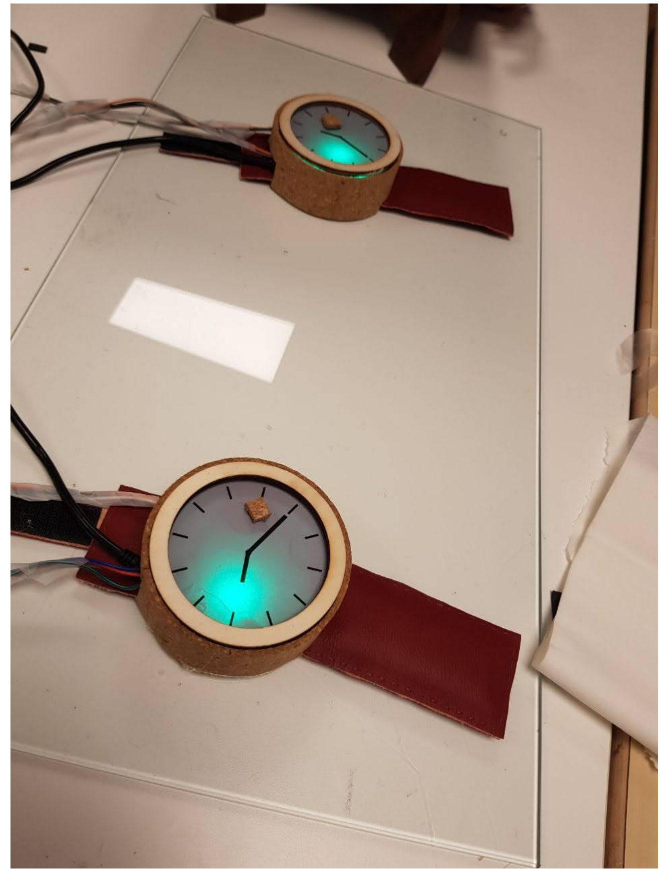

Figure 22: Final version the day of the presentation.

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