Feeling it: sketching haptic interfaces

Camille Moussette
Umeå Institute of Design
Umeå University, 90187, Umeå, Sweden
camille.moussette@dh.umu.se

Abstract
This article discusses some challenges of prototyping haptic (touch) interfaces early on in the design process. It also showcases examples of prototyping activities for haptic interfaces that have strong "sketching qualities".

Introduction
The benefits of prototyping activities are generally well accepted in the Design community [2][3]. Prototypes can be used to test and evaluate possible solutions (usability and requirement-oriented approaches), but they can also be seen as tools to stimulate reflections, objects to frame, refine, and discover possibilities [6].

Over the last decades designers have developed their skills, tools and methods to build prototypes. Numerous tools and systems are currently available to aid, support and ease the prototyping of graphical user interfaces GUI (paper prototyping, screen mock-up, Flash simulator, etc). Outside the realm of the visual and auditory domains, there is limited knowledge and literature how to go about prototyping for the other senses (touch, smell and taste). Recent advances in tools and applications [4][8] have made it more accessible to build tangible and interactive systems that interact with the physical world. Can these tools help prototype and sketch non-traditional interfaces quickly and efficiently?

Protyping haptic interfaces
The skin is a very complex, resilient and refined organ. It offers extreme sensitivity and tremendous capabilities as a medium between the external world (objects and environment) and us. The sense of touch is relatively well understood and documented medically, but designing directly for it (or around it) is very uncommon. Braille and other assistive devices for visually impaired persons have been developed for some time now, but they usually address very specific needs and situations.

Haptic interfaces are most commonly found today in game controllers (force feedback), training simulators and mobile devices (simple vibration). These systems tend to be either very complex and expensive (flight simulator) or extremely trivial (simple vibration). Can designers dive into the subject of haptic and fully explore its capabilities and limits throughout the design process? Is there room for rich, humane and natural-like sensorial experiences using the touch sense?

The sketching or prototyping of haptic interfaces brings interesting challenges for designers:
• How do you create touch stimuli with simple and cheap hardware?
• How do you communicate and document the perception of touch without building the whole system/apparatus? What kind of language or lexicon you need to use?
• How do you account for personal differences in the perception of touch?
• What is sufficiently good or acceptable for haptic feedback?
• What is "low-fi" for haptic interfaces?

These points demonstrate the great difficulties that one has to address in order to prototype haptic and generally other non-traditional interfaces.

Examples of haptic prototypes
The following examples showcase results of recent design activities related to the sketching of haptic interfaces. They were selected mostly for their "sketching qualities", meaning that they are manifestation of early ideas, were quickly put together and have to clear intention of producing "final quality" haptic feedback. They are haptic sketches with just enough information or function to inform the current questions at hand. They try to adhere to The Principles of Prototyping proposed by Lim, Stolterman and Tenenberg [6]:

Fundamental prototyping principle:
Prototyping is an activity with the purpose of creating a manifestation that, in its simplest form, filters the qualities in which designers are interested, without distorting the understanding of the whole.

Economic principle of prototyping:
The best prototype is one that, in the simplest and the most efficient way, makes the possibilities and limitations of a design idea visible and measurable.

The examples are briefly described but the accompanying video presents them in action or in use. The time factor (how long it took to build) is a major factor in prototyping activities. Even tough the domain of haptic interfaces in complex and demanding technically, we believe that quick and dirty prototyping activities are totally possible and very desirable when framed properly in the design process.

In: Wouters, I.H.C.; Tieben, R; Kimman, F.P.F.; Offermans, S.A.M. and Nagtzaam, H.A.H. (Eds.)
'Flirting with the Future', Proceedings of SIDeR '09, April 15-17 2009, Eindhoven University of Technology, the Netherlands.

A group exercise to brainstorm and prototype a haptic mp3 player (2 hours)

Figure 1. Manual testing and brainstorming of haptic features

The haptic "features" (various sequences or stroking gestures) were implemented using common-day items and the Wizard of Oz technique. One of the participants would actuate a miniature hammer (pipe cleaner and magnet) on the extension of the armband, creating tactile stimulation on the user's arm. Other alternatives were explored using small cases fitted with "ribs" and small rocks, that would generate, when tilted steps and notches stimuli in the user's hand. The quality of the haptic feedback was low, rough and not easily reproducible, but the prototypes and the process of building them led to unexpected explorations and discussions among the group's members.

Haptic navigation grip (4 hours)

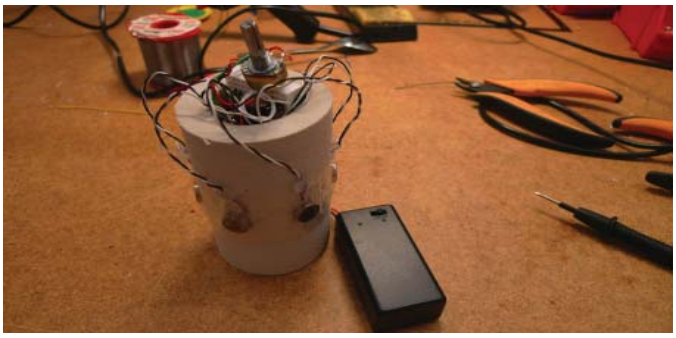

Figure 2. A grip with 7 vibrators, with manual control.

A prototype of a cylindrical grip fitted with seven vibrators around its perimeter. The knob at the top controls the direction of the stimulus. The manual operation (via the know) acts as replacement for an eventual electronic compass that triggers the right vibrator to maintain a specific heading. The prototype showed that the vibration propagates very easily throughout the grip. A decoupling (soft) material or suspension mechanism should be added to properly isolate the source of vibration from the main body of the grip.
Poking grip (1 day)

The prototype was build to test how it would feel if you one part of a handheld device would stick out and poke you palm. The interface was build quickly with servo motors cardboard and pins, controlled with an Arduino board (basic sequences only). The poking action was perceived adequately by users and the prototype was used a proof of concept to continue further the development of this genre of haptic interface.

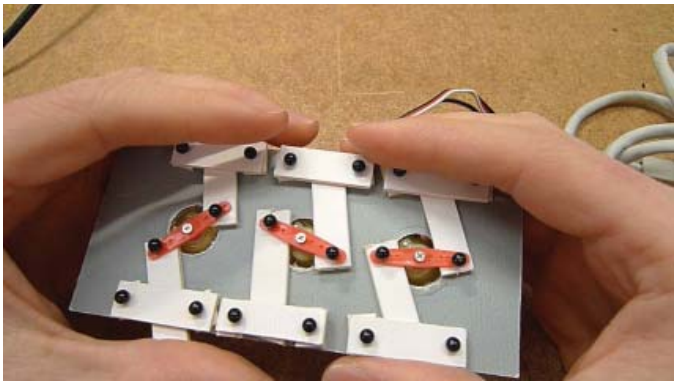

Figure 3. Servo motors to poke the user's hands.

Penta-grip, manual control (3 days)

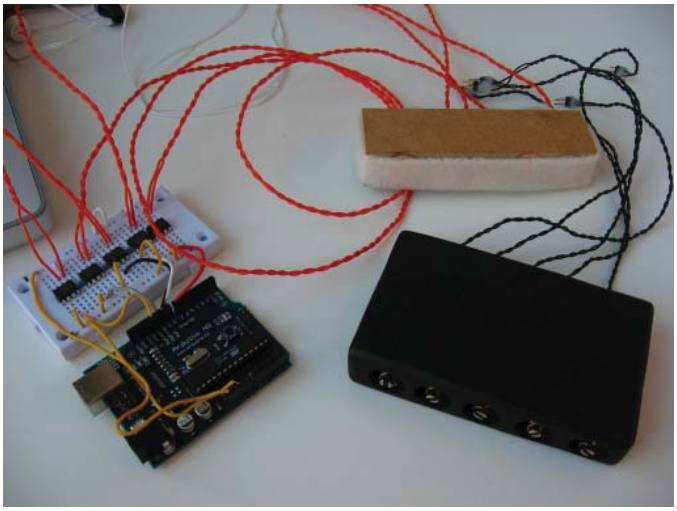

Figure 4. Poking grip actuated via embedded electronics, no computer needed.

A handheld interface using vibration as stimulus. Five nodes can be triggered via a matching controller. No computer or software was needed to activate this prototype. The natural interaction technique, like a puppeteer, allowed free exploration of interesting sequences by many users.
HAPI grip with software (1 week)

Figure 5. Full prototype with advanced features and controlled via software.

This prototype adds computer control capabilities to the penta-grip (described previously) and doubles the number of vibrator to allow left-right stimulation of the interface. The level of development is higher in this prototype but it proved necessary to

obtain proper replicable sequences of vibration. The software controls offer recording and playback functions of the sequences. This implementation was useful to establish and determine valid timing values for sweeping and rolling stimulus [5][7].

Conclusion

Prototyping and sketching of non-traditional interfaces pose new challenges for designers[1]. Very few reference points (and guidelines) exist for exploring and working in these new areas like haptic interfaces. It demands a good reflection about the nature of prototyping itself: how simple or low fidelity is appropriate, desirable and/or justifiable while developing for new (uncommon) senses. The difficulties arise mostly from finding the right balance between complex technical development and sufficient outcomes/results to inform or ground design decisions[3][6].

We have presented various prototypes or sketches of haptic interfaces. They were selected to show that quick hardware sketching and prototyping activities are still possible and have their place, despite the unfamiliarity and complexity of projects involving the touch sense.

References

1.Brewster, S.A., McGookin, D.K. and Miller, C.A. Olfoto: Designing a smell-based interaction. In Proceedings of ACM CHI 2006 (Montreal, Canada), ACM Press Addison-Wesley, pp 653-662

2. Buchenau, M. and Suri, J. F. 2000. Experience prototyping. In Proceedings of the Conference on Designing interactive Systems: Processes, Practices, Methods, and Techniques (New York City, New York, United States, August 17 - 19, 2000). D. Boyarski and W. A. Kellogg, Eds. DIS '00. ACM Press, New York, NY, 424-433.

3.Buxton, B. 2007. Sketching User Experiences: Getting the Design Right and the Right Design,
Morgan Kaufmann, San Francisco, CA.

4.Colin Swindells, Evgeny Maksakov, Karon E. MacLean, "The Role of Prototyping Tools for Haptic Behavior Design," haptics,pp.25, 2006 International Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (HAPTICS'06), 2006 3.Holmquist, L. E. 2006. Sketching in hardware. interactions 13, 1 (Jan. 2006), 47-60.

5.Jyrinki, T. 2004 Perception of Small Device Vibration Characteristics - Test Facilities Setup and Study, Masters thesis. Helsinkink University of Technology. Finland.

6.Lim, Y.-K., Stolterman, E., and Tenenberg, J. 2008. The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. ACM Trans.