

# Engaging the whole body in mobile interaction

Jakob Tholander, Jarmo Laaksolahti, Elsa Kosmack-Vaara, Pedro Ferreira, Tove Jaensson, Ylva Fernaeus  
Mobile Life

Swedish Institute of Computer Science/Stockholm University,  
Box 1263, SE-164 29 Kista, Sweden

[jakobth@dsv.su.se](mailto:jakobth@dsv.su.se), {jarmo}, {elsa}, {pedro}{ylva}@sics.se, tove.jaensson@teliasonera.se

## INTRODUCTION

Research within mobile interaction and applications initially focused on building interfaces that adapt to the limited interaction and presentation resources of mobile devices such as the limited bandwidth and small screens [1]. More recent work has started to address richer interactive experiences by exploring ways of integrating what could be called the “whole body” in interaction in mobile settings. Such work includes for instance location-based systems, social networking, and collaborative applications of different kind.

In line with this development our research investigates embodied and experience-oriented interaction with mobile and tangible devices. In our previous work we have explored a number of themes involving different forms of embodied interactions in support of physical, bodily, emotional, and affective experiences. Together these contribute towards an expanded range of engagement with and around mobile devices and applications.

Some of our recent work addresses themes such as: What kind of actions and interactions are supported by mobile devices? How may we integrate subjective experiences and bodily actions, as well as interactions with bio-sensor data and higher-level representations of these.

Our long term ambition is to explore these novel forms of interaction and how they can be used for developing frameworks for understanding embodied and experience oriented interactions with mobile and tangible devices.

This position paper begins by outlining some of our conceptual starting points. Thereafter we present examples from our work in order to illustrate some of the ways that we have attempted to support bodily forms of interaction in mobile settings. Next, we outline some issues that we need to address in moving towards an interaction framework for mobile devices and applications that incorporates “whole-body” experiences.

## STARTING POINTS

Interaction design and HCI are increasingly attempting to incorporate diverse physical forms as well as bodily engaging activities into interactive devices and applications. This has led to discussions of how such a development shapes the way we look at interaction, and the perspectives we use to describe such forms of interaction. Two strands

that have arisen out of this are embodied and experience-oriented perspectives on interaction, which both have been proposed as ways for moving away from the information- and data centric views that previously dominated HCI. These perspectives emphasize the integration between bodily action and human cognition in the shaping of subjective experiences and interpretations. From such a viewpoint, a broad range of physical, emotional, and cognitive practices comes together in forming human experiences. One of the present concerns in HCI is then to investigate how to provide opportunities for, and also to understand, an expanded range of actions and experiences in relation to interactive devices.

Fernaeus, Tholander, & Jonsson [2] have proposed a model for understanding interaction with tangible artefacts based on what is called an action-centric perspective. Rather than focusing on how information is represented and transmitted this perspective emphasizes the concrete actions that users may take with tangible artefacts. At the end of this paper we will discuss this model in relation to some of the issues that have arisen from our work with applications presented here. Our ambition is to investigate how this perspective can be used for understanding and designing mobile applications and interaction.

## BODILY ENGAGING MOBILE INTERACTION

Some of our applications and studies have attempted to (1), investigate how to design for the interplay between specific physical interactions and emotional expressions thus allowing users to engage in an “affective loop” in which bodily and affective expressions interact to form a rich emotional experience (eMoto), (2) design bodily memorabilia together with location and sensor information to support users in making connections between everyday physical experiences and their daily activities in order to personally reflect on their lifestyles (Affective Diary and Affective Health), (3) to support embodied affective interaction allowing groups of friends to create shared emotional expressions (FriendSense).

### eMoto

eMoto is a mobile service for emotional messaging between friends [3]. The underlying design goal was to create a system that would be physically, intellectually and socially engaging, and also to provide an aesthetic experience. It extends upon mobile text messaging by adding a

background consisting of colors, shapes and animations expressing emotional content to the message.

Backgrounds are selected by using a custom built stylus that picks up on gestures made by the user to navigate a space of visual emotional expressions that corresponds to the gestures that the user makes. First users write the text of their message. They then use the stylus, pressing and moving it while watching the screen to see how the colours, shapes and animations change. Once they reach a part of the space that they find suitable to their message, they click on the send button and the message is sent. The receiver will see both the text but also the graphical background if they have eMoto installed on their phone. If not, they can look it up by a specific web-address.

The design is based on an analysis of emotional body language using the Laban notation [4]. The two main variables in this notation are effort and shape. Effort describes the inner experience of the energy spent performing a movement, while shape describes its form in three dimensional space. Effort and shape were also used as the basis for creating a space of graphical representations; varying in colour, shape, and animation; that corresponds to the gestures [5]. For example, a slow inward movement associated with calmness results in a background of slow, billowing, wavy movements of big, connected, bluish shapes, while an intense, upward directed, happy gesture results in a an intense, bubbly, orange, fast moving background. The system, an example of interaction, and the space of possible expressions can be seen in Figure 1.



**Figure 1 Left to Right: eMoto pen and mobile interface, gesture interaction with eMoto, and the expression circle**

#### **Affective Diary & Affective Health**

A diary provides a useful means to express inner thoughts and record experiences of past events. In re-readings, it also provides a resource for reflection, allowing us to re-experience, brood over or even shed the thoughts and feelings we've associated with events or people. To expand on the ways in which we creatively engage in diary-keeping, we designed an affective diary that captures some of the physical, bodily aspects of experiences and emotions.

The affective diary consists of a logging application running on a mobile phone, bio sensors attached to the user,

and a diary application running on a pc. The system assembles sensor data from the user and uploads it via their mobile phone to the diary application to form an ambiguous, abstract, colourful, body shape (see Figure 2). In addition a range of other materials from the logging application, such as text and MMS messages, photographs, etc., are made



**Figure 2: Visualisation of bodily sensor data on mobile phone**

available to the user. By combining these materials, the diary is designed to invite reflection and allow users to piece together their own stories.

The Affective Health system explores mobile services that empower people to monitor and understand their own stress levels vis-à-vis their everyday activities. The design is based on the ideas of open surfaces [6] and aims to provide users with easy to grasp visualizations of data captured from body sensors and mobile devices. When bio-data and mobile events are mirrored back to the users, the relationship between activities in the world and how they respond to them can help users create meaningful mappings between their experiences and how that affects them.

Affective Health builds on the Affective Diary system and includes most facilities of the latter. However, Affective Diary was not specifically aimed at stress and was not providing feedback in real-time. In Affective Health we would like to provide for a biofeedback loop through using real-time feedback on your mobile phone. Through wirelessly transmitting data from sensors that pick up on pulse, galvanic skin response and pedometers, in real-time to the users' mobile, we can provide for a tight bio-feedback loop. Users can attempt to relax, get more aroused, do sports or other activities that changes pulse and skin conductivity and immediately get feedback on how they are doing.

In addition affective health allows users to look back into the past to be able to discover trends, patterns and hidden characteristics, e.g. sleeping habits and stressed reactions connected to persons or places etc. This in turn empowers them to take control of and cope with stressful situations, increase activities that promote their well-being, or simply change their attitude towards certain aspects of their lives, thereby reducing their negative impact.

One important issue is that the users' experiences will be affected more or less by wearing the sensors. It is therefore

important to make the bio sensors as smooth and seamlessly integrated with the carrier to interfere as little as possible with the user's day-to-day routine.

### FriendSense

Based on our experiences from eMoto and Affective Diary we wanted to investigate emotional and physical interaction within groups of friends, collective affective loops, and co-experience. FriendSense was built as a prototype designed to reveal qualities in affective interaction between friends. It was used as a *technology probe* for letting users experience non-verbal communication and emotional expressions within a group. The users of the system interact through a sensor node that picks up on temperature and vibration. The users' physical interaction with the sensor node generates graphical expressions which are presented on a public display where a collective expression of all users' interactions is formed. To further tailor the expression users may also place a picture inside the graphical representation which makes it possible to distinguish between individuals on the public display. Users can also position themselves in relation to others in the public display. This was used to express social and emotional bonds as well as physical proximity.

The system mediated between two different strands of emotional experience. Emotional closeness, conflicts, and bodily experiences as expressed in the office were transferred, transformed and juxtapositioned against participants' virtual presence and positioning on the public display. What went on inside the system was sometimes equally important as what went on in the office in terms of expressing emotional and physical closeness.

Some of the key conclusions from our first study of the application regarded the relation between the physical actions and the expressions these resulted in. When interacting with a physical object the affordances of the object influence the expressions created with that object, and thereby how users can be in control of the expressions that they arrive at. If the object affords sharp and edgy actions, expressions of anger and frustration might come easier to hand. On the other hand, if the object invites to stroking, patting, or other "soft" interaction behaviours, it may exclude the repertoire of harsh, negative, and frustrated expressions. Hence, a challenge is to tailor the physical actions that an object affords, to the kind of expressions that one wants users to perceive and articulate.

### TOWARDS BODILY INTERACTION WITH MOBILE AND TANGIBLE DEVICES.

Based on our work with bodily engaging affective interaction we are now investigating how an action-centric perspective can be extended for understanding interaction with mobile devices and applications. Our experiences from working with these applications have suggested a number of design themes to further address in relation to bodily interaction with mobile and tangible devices. In the following sections we discuss how some of these themes suggest an expansion of the action-centric model. The

primary aim of the model is to shift the focus of the discourse around tangible interaction from a data and representation centric viewpoint, in favour for viewing tangibles as resources for a wide range of human action. Figure 2 illustrates the four basic forms of action that tangible artefacts provide, i.e., extended possibilities for physical manipulation, for increased space for perception and sensory experience, for referential, social and contextually oriented action, as well as for digitally mediated action. These forms of action are closely interrelated which makes it problematic to discuss them separately.

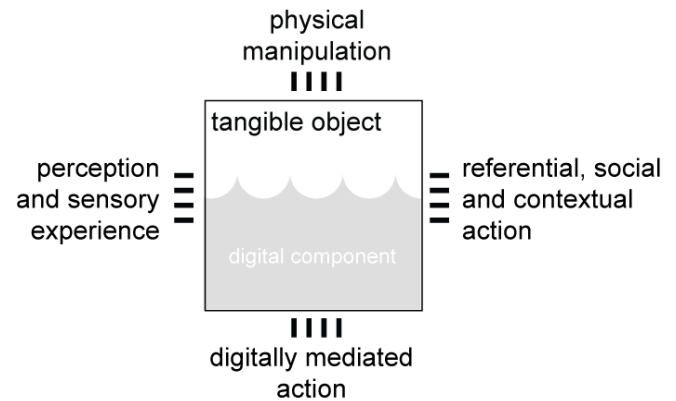


Figure 3: Action centric model of tangible interaction

### Physical manipulation of the devices

In the model presented in figure 3, physical manipulation refers to how the devices may be moved and interacted with in the physical space. This may include anything from more general actions such as users trying to make their devices more personal by placing stickers on them, to how they may get shaped by wear, and how manipulation may be performed with one or both hands, etc. But perhaps most importantly in this case, as with any mobile devices, this includes how the systems may be brought to and used in different places and environments. Such physical manipulation plays an essential part in the design of all of the systems that we have presented here, e.g. how physical nearness is interpreted by the Friendsense system, and how sensors in the Affective Diary and the eMoto pen are traced.

When looking at the physical manipulation more generally, we also see that some aspects of the manipulations noted in our user studies were not necessarily immediate parts of the interaction design, e.g. how the different hardware components may or may not fit into pockets or purses, sometimes cumbersome procedures of changing batteries, and whether the devices may get lost, stolen, hidden, etc. One very salient aspect in this sense noted in both the eMoto as well as in the Affective Diary projects, was how the technology was sometimes hard to hide away in public settings. All of these aspects could be counted as what Fernaeus et al refer to as *off-line actions*, i.e. actions not

sensed by the system, but yet of central relevance for the whole experience.

### **Perception and sensory experience**

Perception and sensory experiences refers to how users sense and experience the different ways that an interactive artefact is manifested in use. In this case, this includes how it felt like to wear the sensor nodes, the relationship of the computer representation and felt bodily actions, and how the systems were physically as well as digitally represented more largely. As all of these systems were designed for very specific hardware, important in these cases were device-specific experiences of the senses, e.g. to feel weight, texture, hotness, etc. Concrete examples from our user studies were the importance of the shape of the eMoto pen (which was considered too large, and with a somewhat inappropriate shape), and how the shape and form of the sensornodes used in Friendsense probe affected how users eventually manipulated them.

A main aspect of our design efforts concerned designing for perception and emotional sense making of digital expressions, primarily through designing sound and visuals on the screen. An important aspect with regards to this noted in the eMoto study was for instance that of timing, where even a short lag could result in losing the important sense of being in the ‘affective loop’.

With the systems presented here we attempt to explore different ways of supporting *personal and physically engaging expressions* where bodily and emotional, cognitive and social engagement is integrated. By allowing users to construct their own *subjective interpretations* of projections of their own bodily data, users may experience, reflect upon, and build relationships to their bodily sensations and actions in novel ways.

Engaging users in *sensing and perceiving bodily action* in meaningful ways may range from interpreting measurements of bio-sensor data that are largely out of the users’ explicit control, to sensing of specific physical actions such as shaking of the stylus for positioning in a specific screen location.

### **Referential, social and contextually oriented action**

This dimension of the model concerns actions that are not directly directed to the system or the artefact per se, but towards the context around it. This includes for instance co-located social interaction where the system or device is used as part of the interaction, as well as communication through the device at a distance. As with most mobile applications, these forms of actions were essential in the design of all the systems that we presented here, for instance in the role of collocated action in FriendSense and the essence of transferring gesture data at a distance by eMoto.

This may range from the way we hold a mobile device in order to invite someone to look at the screen, to the ways that we hide our actions from others when interacting with a mobile device in a public space. The role of bodily action

for establishing and maintaining shared activity has become an increasingly important theme in design of tangibles for co-located activity. However, the applications discussed here goes further by addressing shared dimensions and the role of bodily action with mobile devices for *social and collaborative action in distributed settings*.

Contextual aspects such as intended and unintended audiences of the interaction were also central in all of our studies. One example was how users felt awkward using the eMoto pen gestures in public settings, and how wearing the visible sensor nodes in affective diary resulted in curious glances and questions from others. To visibly wear and use new and unusual technology among other people naturally leads to some attention, regardless one intend it or not. In this sense, the physical devices could be seen to also serve the purpose of indicating the current state of the activity.

### **Digitally mediated action**

Digitally mediated action refers how the users can use the system or device for interacting with digital forms of representations and expressions. In this case, all of the systems that we have presented illustrate new means for control and performance with computational systems, e.g. through different forms of sensors and visual expressions. An example is how the eMoto pen is used for navigating in the visual space of animated expressions, illustrating new and potentially richer interfaces for manipulating digital materials. Other aspects that this dimension include are access to online and recorded content, e.g. the different forms of media collected by Affective Diary, how these could be tied to a specific time or location. In the case of applications that rely on sensing of body data the control of the expression is more explicit like in eMoto or more implicit like in Affective Health. An important theme then regards *how the expressions are manipulated and controlled* and what actions affect the expression.

### **CONCLUSIONS**

The action-centric model was developed to put emphasis on the rich and multifaceted range of actions that users may engage in with and around tangible artefacts. Analysing application and artefacts from such a perspective provides for a broad understanding of particular qualities of an application, as well as the different ways user’s experience these. From this perspective, analysing the applications discussed here, focus on the different ways for the user to control the expressions they create and different ways of perceiving and sensing bodily action. Furthermore, the applications support different *types of bodily engagement* and ways of bodily influence on the system. These may range from highly explicit actions for creating the expression like in the eMoto-application, to sensing and representations of bodily data that in a more indirect way contribute to the user’s construction and interpretation of the expression. Importantly, from a “whole body” perspective on interaction, these aspects include also actions not immediately sensed by or designed into the interactive systems.

## REFERENCES

1. Brewster, S., *Overcoming the Lack of Screen Space on Mobile Computers*. Personal Ubiquitous Comput., 2002. 6(3): p. 188-205.
2. Fernaeus, Y., J. Tholander, and M. Jonsson, *Beyond representations: towards an action-centric perspective on tangible interaction*. Int. J. Arts and Technology, in press.
3. Sundström, P., A. Ståhl, and K. Höök, *IN SITU INFORMANTS EXPLORING AN EMOTIONAL MOBILE MESSAGING SYSTEM IN THEIR EVERYDAY PRACTICE* Special issue of IJHCS on Evaluating Affective Interfaces, 2007. 65(4): p. 388-403.
4. Davies, E., *Beyond Dance: Labans Legacy of Movements Analysis*. 2001, London: Brechin Books ltd.
5. Ståhl, A., P. Sundström, and K. Höök, *A Foundation for Emotional Expressivity*, in *DUX*. 2005, ACM: San Francisco, California, USA.
6. Höök, K., *Designing open familiar surfaces*, in *NordiCHI*. 2006, ACM.

**The columns on the last page should be of approximately equal length.**