Intimate Mobiles: Organic Actuation through Pressure, Moisture, and Atmosphere in Mobile Phones

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Abstract
In this paper, we propose three novel modalities of actuation for mobile devices: pressure, moisture, and atmosphere. We review the relevant literature and give a description of the employed technology. We propose three areas of application: Ergonomics, Input/Output, and Telepresence. We then discuss the proposal, pointing to possible concerns and implications on future designs.

Keywords
Pressure, moisture, atmosphere, tightness, wetness, airstream, mobile phone, haptic display

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

Fig. 1: Tightness prototype.

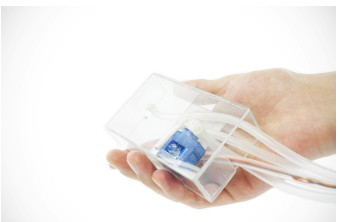

Fig. 2: Wetness prototype.

Fig. 3: Tightness prototype.

Introduction

One of the theoretical frameworks that have been proposed to conceptualize the last decade's developments in Human-Computer Interaction (HCI) is Embodied Interaction [4]. It proposes the combination of the *tangible* and the *social* computing domains. The interaction techniques proposed in this paper are located in the overlap of the extremes of the tangible and the social, in the *intimate space*.

Background

The intimate space is perceived through various channels, one of which is the cutaneous sensory system. Related work to this proposal is presented in three categories concerned with cutaneous actuation: tightness, wetness, and airflow.

Tightness

Motion restriction can be a strategy to provide feedback and guidance to users motions, and it can be achieved both actively – through motors – as in the Spidar [6] system, and passively – through brakes – as in the Reflective Haptics [12] project. With regard to flexible handheld devices and OUIs, it appears worthwhile to investigate what happens when the device can be bent *around* the user's hand, and how the resulting effect of tightness can be used as a means of interaction.

Wetness

Recently proposed interaction techniques include the usage of water as an interactive surface for domestic computing [11] or virtual reality applications [2, 8]. Furthermore, Roy et al. recently proposed a door lock that required a kiss to be opened [9], while Dornberger et al. investigated the mouth as a means of musical interaction [3]. User reactions to these projects underlined the intimacy of the involved wetness. Sylvester et al. [10] proposed an alternative approach for touch interaction, through smoke-filled bubbles that rested on an interactive water surface. With regard to OUIs, exploring flexible interactive surfaces may also benefit from the exploration of liquids as a means of interactions.

Airflow

Airflow-based systems have been proposed as ambient displays by Ishii et al. in the PinWheels project [5], on an architectural level, and later on investigated for haptic feedback in finger-scale sizes in handheld devices by Amemiya et al. [1] and Kim et al. [7]. Such research may beneficial as an inspirational source for new endeavours in natural behavior-inspired interactions, including OUIs.

Applications

The proposed means of actuation allow for a variety of applications. They can be of use in *Ergonomics* – solely dealing with the device itself, for *Information* – representing the digital content in the device, and in *Communication*, enriching telepresence (Table 1).

	Ergonomics	Information	Communication
Tightness	*Gripping*	*Tightness as a Display*	*Touching and Grasping*
Wetness	*Cleaning*	*Internal Statuses*	*Kissing and Crying*
Airflow	*Cooling*	*Finger Guidance*	*Laughing and Whispering*

Table 1: Overview over interaction techniques and domains.

Fig. 4: Tightness actuation.

Fig. 5: Wetness actuation.

Fig. 6: Airflow actuation.

Tightness

We propose a tightness actuation system that, through a hand loop (Fig. 4), is enabled to pull the user's hand towards the backside of the mobile phone. The loop can be extended from the mobile phone and mounted in different angles, allowing for different styles of holding it.

The system thereby allows for drop prevention through software-controlled adhesiveness – for instance, the phone can be affixed to the user's hand while engaging in bodily activities or while making privacy-critical actions.

Furthermore, the system allows for pressure-based information conveyance. For instance, in jogging, it could display information about how one's current performance compares to previous performances through the tightness exerted on one's arm.

Ultimately, such a system would enable two users, speaking on the phone, to use manual grasp as a means of telepresence. Pressing a so-enabled mobile phone harder would cause the motorized loop on the other phone to pull tighter, enabling users to feel their hands over the distance, and potentially giving them a sensation of nearness.

Wetness

The second proposal is a system for wetness actuation in mobile phones, consisting of two different types of moisture outlets: Surface (or touch screen) perforation and a motorized sponge. Surface perforation requires the moisture intensity to be controlled through valves or the connected pump, while the sponge can be filled first, and then be pressed against the device's semi-permeable casing.

Such a system, provided with the necessary sensors, could provide liquids dispensation in response to dirt on the surface. It could moisture its surface with cleansers, protectives and sealing liquids, and it could thereby add to the device's maintenance and care.

Liquids may hold the potential for intense, emotion-laden interaction, and could thereby allow for empathy-based information displays. The phone could display internal statuses through simulated body liquids, such as blood (e.g. to symbolize hurt), sweat (e.g. to symbolize stress), and tears (e.g. to symbolize sadness).

Lastly, wetness can add to the experience of talking on the phone, conveying the communication partner's perspiration or crying. Feeling someone else's tears through the phone may be awkward, but could help us to understand new ways of how telecommunication could be emotionally enriched.

Airflow

Thirdly, we propose a system that may benefit from its subtlety: Airflow. Our system consists of a set of three different air jets in the device, allowing for different types of airstream generation.

The system may allow for simple, airflow-enabled cooling. Users may benefit from this, as heating is considered a common issue with mobile devices, especially in times of prolonged usage.

Airflow can also be used as a means of information display – the air jet can be direct outwards, to reject the user's finger (e.g. when performing a critical action, such as deleting a file or contact), to attract the user's finger (e.g. as a guide towards an action that is recommended, such as confirming a default setting).

The system can ultimately be used for the simulation of wheezing. Feeling the conversation partner's nostril airstream through a jet towards the neck, the verbal plosives' and guttural sounds' airstreams through a jet towards the cheek, and the caller's environmental airstream (e.g. the surrounding athmosphere) through a jet towards the head could add to the phone call experience and, again, provide a feeling of nearness.

Discussion and Outlook

The proposed styles of interaction are based in the intimate space, which brings along a set of implications. It raises questions about how closely we want to interact with technology.

We find ourselves in the dilemma of awkwardness and burdensomeness on the one hand, and richness and intensity on the other.

As for future work in this field, we encourage studies on the acceptance of the proposed styles of interaction.

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