Ambient Life: Calm and Excited Pulsation as a Means of Life-like Permanent Tactile Status Display in Mobile Phones

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Abstract

In this paper we present Ambient Life, a novel notification system for mobile phones. It is based on a cognitive mechanism that humans are inherently good at: the perception of life. The proposed system employs basic life-like movements, like breath and pulse, to display the state of a mobile phone. The phone can either be “calm” (representing no missed calls, SMS or similar) or “excited” (representing missed events, requiring attention). Two prototypes and a user study are presented. The outcomes of the study are mixed; while most users generally liked the idea of a living phone and were able to determine changes in the pulse frequency almost instantly, the acceptance of the new functionality depended strongly on the situation the phone was used in.

Conference theme: User Interface Design
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Introduction

Overload, distraction and interruption are major problems in the information age [**2**, **7**, **20**] – an issue that often motivated investigations in the field of *ambient displays*. Designed to present information at the edge of perception, they have been integrated into furniture objects [**8**] and architecture [**11**], and, more recently, also into mobile phones. These explorations included various wearables [**5**, **18**] and accessories [**6**], and also the mobile phone's display [**15**] itself.

More specifically, *tactile interaction design* has attracted special attention within the field of ambient displays, leading to new approaches to mobile ambient displays, including excitatory feedback [**19**], shape [**9**] and surface changes [**10**]. All of these, even though most of them are still on the level of prototypes, seem indeed more viable than audiovisual cues, given the sensory limitations of mobile HCI.

Creating ambient awareness for the phone's state is a worthwhile undertaking, given the omnipresence of the mobile phone, and the issues of overload, distraction and interruption mentioned above – just recently, new psychosomatic syndromes, such as the *phantom ringing* and the *phantom vibration* have been described [**7**].

This reveals a remarkable gap: In mobile phones, notification and distraction make up a striking dilemma [**3**]. The current problem with mobile phones is that they notify the user at the time of an event, but remain silent afterwards. This lures their users into states of permanent checking, as they have to pull out the phone of their pockets to see if it displays a missed event. That stresses the question of how people could be constantly aware of state of their phone, *without* being overloaded or distracted.

If we understood more about permanent ambient information displays in mobile phones, this would eventually allow designers to create systems of less overload, less distraction and less interruption, and could henceforth help users to interact with technology more calmly [**17**] and conveniently.

It should be noted that, even if we eventually found a way people *could* be ambiently aware of their phones' states, we cannot judge if they actually *should* be. Still, we claim that current notification principles in mobile phones, ringing and vibration bursts limited to the duration of an incoming event, are not truly satisfying, and could at least be augmented by a system of

permanent information display, based on something that humans are fundamentally good at: The perception of life.

Hypothesis

As psychological research has indicated, humans are inherently well-trained to perceive life [**14**, **13**, **4**]. Therefore, signs of life could be a rewarding approach to notification in mobile phones: An interaction principle based on these signals could allow the user to get a *feeling for the device*. Ideally, as we have pointed out above, this would make use of neither the auditory nor the visual channel, and rather subtly communicate through the channel of tactility. Such a system would not replace traditional patterns like ringing or vibration alerts, but rather fills the "gaps" between events (Fig.1).

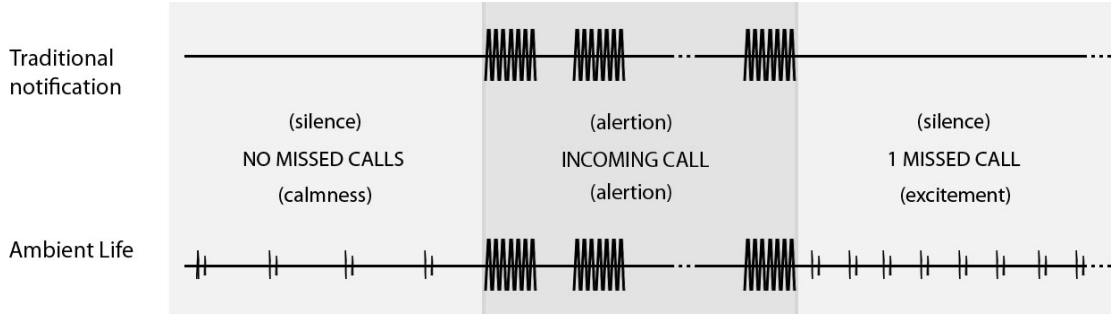

Fig. 1: Traditional notification system (top), proposed system (bottom)

We propose *Ambient Life*, a mobile phone, using a number of actuators to constantly simulate basic life-like signals like breathing and pulse. These tokens are used to articulate the state of the phone in a subtle, natural manner.

The system simulates *excitement* (high pulse, as for a missed call/sms/appointment) and, more importantly, *calmness* (normal pulse, i.e. as for sufficient battery, good network reception, and no missed events). Opposed to all other mobile phones, it actively communicates that everything is fine, and that there is *no need to check* it.

As an initial prototype, we equipped an empty mobile phone shell with two servo motors and two vibration motors (Fig. 2). Due to the power consumption and the sheer size of the motors, the system was simply not suitable for actually mobile usage.

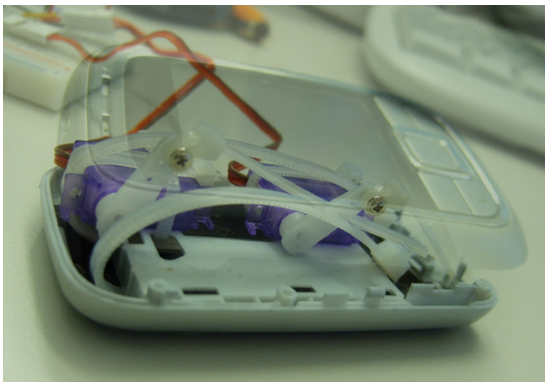

Fig. 2: First prototype; mobile phone case with servo motors (“breast” and “stomach”)

Permanent tactile input in a life-like manner from a mobile phone, however, raises several questions that should indeed be investigated mobile phone study. We therefore decided to utilize the vibration motor that is already used in most mobile phones and develop a piece of software that would power the motor in a pulse-like rhythm. Even though this meant that we would no longer be able to include the “breathing” expansion of the phone, this would, in turn, allow us to make real-life observations. Would users take notice of a change in the vibration pattern? Or would permanent tactile actuation simply annoy them? In order to find out if the proposed functionality is a suitable means of permanent tactile notification on mobile phones, these questions need to be answered. We formalized them into two hypotheses:

H1 (Habituation hypothesis): The pulse is habituated after a certain time, and not distracting the user any longer.

H2 (Change detection hypothesis): Sudden changes in the vibration pattern (such as a change from “calm” to “excited”) are noticed immediately if body contact is upheld.

Prototype

The mobile phone we used for the real-life study was the SonyEricsson W880i (Fig. 3). We wrote a Java application that controlled the phone’s vibration motor in the desired way: By powering the motor for less than 20 milliseconds, it was possible to rotate its excenter axis less for than one full circular motion, resulting in, rather than a vibration, a single distinct beat. Shortening and enhancing the time that the motor is powered results in respectively more subtle, incomplete beats, or, if enhanced enough, in the typical “incoming call” vibration.

The phone switched between two states: “calm” (ca. 50 heartbeats per minute) and “excited” (ca. 100 heartbeats per minute). The software used did not access the actual call log of the mobile phone, as opposed to the original concept posed; instead, we simulated incoming events

and set the phone to “excited” every 120min ± 10min. The phone remained “calm” from 9 p.m. to 9 a.m., which was a fact the users were informed about in advance. The battery of the phone usually lasts for about 40 hours, but due to the power consumption of the vibration motor, it went down to a maximum of 6 hours in the study.

Fig. 3: Second prototype, with keyboard configuration

Data collection methods

The conducted study combines two parts of qualitative research: (1) User observation and diaries, and (2) user interviews. The diaries include both hand-written diaries and automatically generated log files on the phones used. The interviews were semi-structured; the users were asked open-ended questions about their experience with the phone.

The phones were able to switch between „calm“ and „excited“, and users were asked to press „OK“ as soon as they noticed that the phone was in the „excited“ mode. The phones were logging every event and every key press to a text file, which allowed us to measure the reaction times to changing vibration patterns (“calm → excited”).

After the test, the users were interviewed, and the interviews were recorded on video tape. The questions asked included “How did the feeling of the pulse change for you, after the first hours?” and “Did you encounter any situations in which the pulse was either very pleasant, or very annoying?” and further questions regarding the subjective experience.

Users

7 users (3f, 4m, 20-33 yrs.) took part in the user study. As a short survey revealed, their mobile phone behavior varied; among them were both frequent and occasional users. They were not informed about the expected outcomes in advance.

Task

The subjects were asked to wear the phone in a comfortable way: They were allowed to adjust the *intensity of the pulse* (while the *frequency* of the pulse was determined by the state of the system). They were not required to carry the phone all the time. They were encouraged to keep a simple, hand-written diary during the test period, with special regard to different situations (train, bus, office, bed, etc.). As the battery life of the phone had decreased to a maximum of 6 hours; the users would eventually have to charge the phone. The duration of the test varied between the users, four users kept it for 12 hours, three kept the prototype for 3 days.

Results

In this section, we present the results of the study, beginning with the quantitative part, and continuing with the qualitative part.

We recorded 178 “excitement → confirmation” events. The measured occurences of different reaction times are depicted in Fig. 4. The overall range of the reaction times to an “excited” event was broad; we were, however, able to categorize three groups, one accumulating around an average time of 5 seconds, one accumulating around an average time of 12 seconds, and a long, flat tail from 20 seconds up to 20 minutes (which is not entirely depicted in Fig. 4). The users changed the pulse intensity, on average, every hour. We found, however, no effect of the pulse intensity on the reaction time.

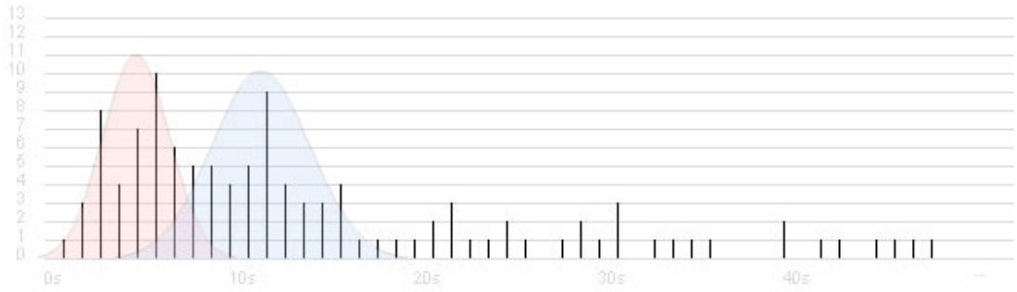

Fig. 4: Event reaction times histogram (< 50 seconds), summits at 5 seconds (“immediate response”) and 12 seconds (“delayed rsponse”).

Most of the users generally liked the idea of a living phone, and that the intensity of the pulse was variable and easily adjustable. It was reported that permanent vibration would take away a part of the original vibration motor's "clearliness" in terms of "something happened". In terms of acceptance of this particular prototype, the results were mixed – while some users entirely disliked the "annoying, permanent" pulsing, others reported it to be "unobtrusive" and "conveniently available only on demand, when I put my hand on it". Two subjects reported that over time, they got used to the pulse and were able to ignore it. All other subjects reported that over time, the pulse got more and more annoying. One user reported that the phone went hot due to too much vibration. Furthermore, some users proposed that the phone should only articulate the pulse „on demand", for example, when touched by a hand, or squeezed through the pocket, similar to like feeling a human pulse, which also requires a gentle, focused touch.

The users reported different impressions of how they felt with the phone, depending on the situation they were using it in. We categorized the reported situations into three different types:

At work: One user reported that he could either concentrate on the phone, or, otherwisely, ignore it totally. No user reported that the phone was soothing or calming him, the case was rather the opposite: All users found the phone to be "annoying" in at least one situation, and this situation was always one in a silent environment, where concentration on something else was needed (e.g. in the office, while working).

At rest: One subject particularly reported that it would be good to "know that the phone is there". Some users took the phone into bed, and reported it to be "annoying". Interestingly, users reported that "something is missing", once the phone has been taken out of the pocket after wearing it for a while.

On the go: Several users reported that they found it hard to discriminate if the phone was excited or calm without looking at it, especially while walking or in noisy environments. One user reported that "on the train" was a suitable place for the functionality to be used. Overall, transport conditions were reported to require harder vibrations.

Discussion

It can be concluded that in most cases the users were simply annoyed by the pulse. This was surprising for us, as we assumed that the pulse would easily blend into the user's perception, and vanish until it would eventually change to the "excited" mode.

The users reported that the pulse was annoying the most in situations that involved silence, focused attention, or resting. It seems that the more noise was involved in the situation, the less annoying the pulse was for the users.

The users often pointed out an ideal state of “on demand” information, in which the pulse was so subtle that they did not feel it without putting their hand on the pocket. This means that users still checked their phones, only *through* the pocket. With regard to the original problem posed, the functionality did not give them a permanent feeling for their phone, it just facilitated checking it.

The reaction times to a „excitement“ event typically fell into one of three groups, one, as we claim, for each of the conditions „phone held in hand“ (immediate response), „phone in pocket (body contact, response after taking out), „phone afar“ (no body/visual contact, notification failed). Most users reported they had no problems to distinguish between “calm” and “excited”.

With regard to our hypotheses, we conclude the following:

H1 (Habituation hypothesis): The results of this study do not confirm this hypothesis. Rather, the perception of the permanent vibration depended on the situation the users were in: While a focused, work-like situation that required the unshared attention of the user led to statements like “annoying” or “nagging”, even though they had worn the pulse for hours already, on the other hand, noisy situations (train, discotheque) facilitated more comfortable feelings while wearing the pulse.

H2 (Change detection hypothesis): The data we gained from the phones’ log files and the users’ statements in the interviews support this hypothesis. The reaction times accumulate in a “delayed response” hill, separated from the “immediate response” hill, around the 11 seconds mark, which might well resemble the time required to take the phone out of the pocket and push the “OK” button: The users had no visual contact, and yet discovered the change in the vibration pattern. This is confirmed by the statements given in the user interviews.

Based on the findings of this investigation, we draw the following conclusions for the design of life-like tactile mobile notification systems.

Conclusion

The situations in which the phone would be perceived as annoying were more than we expected, and the habituation hypothesis was rejected. Obviously, different situations require different pulse intensities, and in very quiet situations, the pulse should be turned off. It could therefore be worthwhile to add a component to the system that would automatically adjust the pulse intensity to the kinetic and acoustic noise of the current situation.

Users reported that they liked the fact that they were able to have the phone's information ready "on demand" – which might mean that they still checked their phones, and this would contradict our original assumption that the proposed system would help users to not check their phones anymore. In this case, they just did not have to take the phone out of the pocket, which underlines the convenience of "through the pocket interaction" [**9**], but leaves the question of how to achieve permanent notification on mobile phones in a non-bothersome way.

This study has revealed new insights into permanent tactile notification systems in mobile phones; it has clearified issues and also pointed out ways to approach them. The fact that the habituation hypothesis was rejected and the change detection hypothesis was supported lets us conclude that the proposed system has potential for notification purposes, but needs to be more subtle and ignorable.

One of the most striking findings, however, is the psychological gap the phone left when it was taken out of the pocket, as some users reported, that underlines the question if users *should* be informed permanently about the state of their phones: Already, users report that "something is missing" when they leave the house without their mobile phone [**12**], and a permanent tactile input as we propose it might probably even amplify this.

The proposed way of tactile information display is a promising area of research, but it should be handled with care: Too quickly users are simply annoyed by a permanent touch. For now, we conclude that any cues used by the system should be easily ignorable, and that more research needs to go into life-like signs, as to include them as a truly valuable means.

Outlook

Clearly, a long-term study is needed. How much of the "external" pulse is internalized? How does the relationship to the phone change? Finally, it could be hypothesized that – when used in the right way – a calm pulse close to the body (as in baby [**16**] and animal [**1**] soothing systems) is, by itself, calming and soothing.

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