Ambient Life: Interrupted Permanent Tactile Life-like Actuation as a Status Display in Mobile Phones

Fabian Hemmert
Deutsche Telekom Laboratories
Ernst-Reuter-Platz 7
10587 Berlin, Germany
fabian.hemmert@telekom.de

ABSTRACT
In this paper, a novel means of status display in mobile phones is discussed: A permanent tactile heartbeat-like pulsation of the phone. In the study presented, this pulse was used to let the phone continuously communicate a calm state of 'Everything is okay.' – then, this pulse was suddenly interrupted, as soon as the phone needed the user's attention. We hypothesized that the users would instantly notice the missing pulse.

The participants in our study wore the phone for one day and were interviewed afterwards. Also, a log file about the events and user responses was kept on the phone.

The results suggest that the proposed system is not sufficient as a means of notification; only 55% of the events were noticed within the first minute. While some users were simply annoyed by the pulse, others did like the reassurance that the phone was 'present and calm', but 'easy to ignore' at the same time. These results indicate that the system might be eligible as an ambient status display for mobile phones.

Author Keywords
Mobile phone, tactile actuation, notification, annoyance, status display, silence

ACM Classification Keywords
H5.1. Information interfaces and presentation

INTRODUCTION
When carrying a mobile phone, the state of 'not ringing' is currently ambiguous: It might mean that *nothing happened*, that a call was *missed* (Fig. 1a), that the phone is *off* or that it is simply *not there*. Mobile phones do not employ a clearly distinguishable state of 'I'm here, and everything is fine.'.

Regardless of where and how the phone is worn, mobile phone users are bound to miss calls sometimes [12] - and this can lure them into a habit of frequently checking their phone for missed events. In this context, new psychosomatic syndromes have been described, *phantom ringing* (or 'ringxiety') and *phantom vibration*s ('vibranxiety') – which points out the often problematic character of current mobile phone information systems [8, 16].

In on-the-go interaction, the audiovisual senses are often busy, or simply not applicable as a channel of interaction, and so utilizing the modality of touch is promising: Tactility and proprioception have come to special attention in mobile interaction design.

RELATED WORK
Existing research has investigated different ways of vibrotactile, surface- and shape-based information design for mobile devices: Brewster, Brown et al. proposed *Tactons* [3] to convey information to the user through vibrotactile patterns; in order to create a feeling for who is calling [4]. Horev [11] proposed dynamic haptic icons on a device's surface, while the FlashBag USB stick and the Dynamic Knobs phone [10] change their shape according to their internal status. However, none of these systems can easily be realized using existing mobile phone hardware. A simple system that utilizes the common vibration motor is therefore desirable.

Some existing mobile phones ([15], e.g.) have the feature to vibrate every 5 minutes after a missed call – however, this leaves the problem unsolved for the time remaining between these reminders: During this time, the phone is silent, and still requires to be checked.

Other recently released mobile phones [14] feature a button for a 'tactile echo' of the phone: When the button is pressed, the phone will vibrate in a certain pattern, depending on its state (short vibration = nothing happened, two short vibrations = text message, one long vibration = missed call, etc.). While the principle itself is very efficient, as the phone can be checked through the pocket, the cognitive effort to read 'decode' the vibration pattern is still considerably high.

Investigating a system based on patterns that we understand inherently, and cognitively effortless, might be worthwhile, especially in the age of distraction, interruption and information overload [1, 2, 7]. Therefore, we recently proposed a system that uses a calm and a excited pulse as a means of status display for missed events on the mobile phone [9].

The concept of a 'living' mobile phone is based on the hypothesis that as social beings, we are inherently able to interpret signs of life. For example, psychological research has shown that children are able to categorize living and non-living objects already in early phases of their development [6, 17, 18]. What was in question was if an ambient information system could be based on these instinctive abilities.

The difference of this study to its predecessor [9] (Fig. 1b) is that in this case, the pulse would not switch into an 'excited' mode upon a missed event, it would instead stop (Fig. 1c). Because of the user comments in the previous study, we hypothesized that the users would instantly take notice of the missing pulse: They reported a 'gap' when they took the phone out of their pocket in the evening.

PROTOTYPE AND USER STUDY

The prototype in our study consisted of a Sony Ericsson W880i mobile phone, which was running a Java application: The software continuously generated short, pulses on the phone's vibration motor. For every heartbeat, which occurred every 800ms, the vibration motor was activated twice in a short sequence, resulting in the classical heartbeat rhythm.

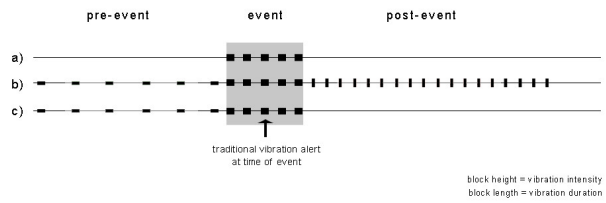

Fig. 1: Vibration occurrence and intensity in a) traditional notification; b) the calmness/excitement-based system [9]; c) the system discussed in this paper (stopped pulse signalizes need for attention)

The intensity of the vibration could be adjusted by the users. The available strength reached from very subtle beats ('ticks', resulting from less than one rotation of the vibration motor) to distinct, repetitive 'vibration motor vibrations' (multiple rotations of the motor). The heartbeat-like rhythm, however, was existent for all intensities.

The default intensity was a 50ms activation of the vibration motor, resulting in a subtle force, comparable to a gentle touch of a finger. According to another study, this is a 'comfortable' [13] intensity for tactile actuation.

We conducted a qualitative user study with 6 users (3f, 3m, 22-33 yrs.). We used video interviews and user observation through log files on the phones as our methods of inquiry.

The software simulated a missed event and stopped generating the pulse at some randomly selected point of time (with a minimum distance of 10 minutes between the events), which was written to a log file. The users were asked to push the 'OK' button on the phone as soon as they noticed that the pulse hat stopped (to 'reanimate' it). No other cues for the event, like ringing or traditional vibration alert, were given. All subjects were familiar with the device already, as they took part in the previous study [9] as well. The users wore the phone for one day, and all users wore their own mobile phones in addition.

The users were encouraged to keep a diary of their activities while carrying the phone, with special regard to situations in which using the functionality would be different than in others (e.g. in a library, as opposed to at a concert).

RESULTS

The users reported that the suitability of the functionality as a means of notification depended on the strength of the vibration and the situation they were in – sometimes, they would just miss it when it is not strong enough. At the same time, the stronger the vibration was, the more annoying they found it. Most users stated that they were able to ignore the pulse at low intensities, and shift their attention to it to check it 'on demand'. At higher intensities, the system was mostly found to be "very annoying". Users reported that they were well able to perceive the pulse while sitting in a calm environment, and were hence able to react to its sudden end. While walking, they were not able to feel the pulse, and had to 'check' for it by grasping the phone through or in the pocket.

Some users particularly enjoyed that either 'everything was fine', or, be it 'because of a missed event' or 'because I did not wear it close enough', it required them to do something. Silence, in this system, is never good.

Users stated that they found it difficult to immediately react to the death of the phone and that they often had the feeling of being 'too late'. They also reported an 'inverted phantom vibration', in which they thought the phone had stopped beating, but it had not. Overall, the users felt that they were not really good reacting to the stopped pulse, and estimated the average common time to be about five minutes. They reported that when they checked their phone, which was

often ‘accidentally’, that it was often dead already, presumably for a longer time.

The log files revealed the actual reaction times (to a total number of 194 events): 19% of the responses occurred within the first 10 seconds, 44% within the first 30 seconds. 55% of the responses to a stopped beat occurred in the first minute after the event (Fig. 2). After 10 minutes, 90% of the events were confirmed.

DISCUSSION

Many users in our test group were quickly annoyed by the pulse, only few got used to it. Similar to the previous study, the pulse was found to be more annoying in silent situations, while it was rated ‘easily ignorable’ and ‘helpful’ in busy situations.

The permanent tactile stimulation that the system produced was helpful for the users to be aware of their tactile contact to the device. For people in special user groups (e.g., emergency doctors or security staff) that have to be permanently sure that their network reception, battery status, etc. are fine, that they have no calls missed, and that they have not lost tactile contact with the device, such a ongoing reassurance could be helpful.

A result of only 19% recognition rate within the first 10 seconds and 55% within the first minute is not sufficient for a notification system. Instead, it seems more plausible to use the system as a permanent status display.

Even though the task ‘When the heartbeat stops, press the center button to reanimate it.’ was plausible to the users, they did not state that they treated or perceived the phone as a pet: While the metaphor of the ‘living phone’ was clear, it is still uncertain if a non-lifelike stimulation would have produced different results.

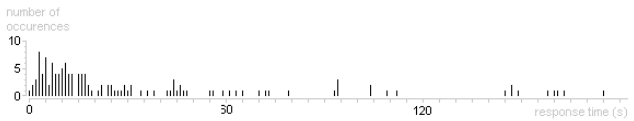

Fig. 2: User response times to interrupted pulse

Interestingly, the users stated that they ‘just accidentally’ looked at the phone when they discovered that the pulse had stopped. It is, however, unlikely that every user accidentally checked the phone every minute. What might be possible instead is that they took notice of the stopped pulse subconsciously. It has been argued before that some decisions are largely based on external subconscious cues, even though they feel like free will [5].

Permanent life-like tactile actuation as we propose it should be looked at critically: We do not know the bodily and psychological consequences of a continuous external heartbeat – nonetheless, we think that it is a worthwhile undertaking to study it.

CONCLUSION

This research cannot answer the question of whether permanent information should be preferred over permanent checking. Still, a status display like the one proposed might be suitable for users that need permanent reassurance about their phone’s status.

People that show addictive behavior to their mobile phones should also be taken into consideration. The permanent stimulation might satisfy their need to be in touch with the phone, but in terms of addiction, it might make things worse.

This study contributes to the ongoing research in tactile mobile interaction design. The proposed system cannot replace traditional notification and status display systems, but investigating permanent systems is worthwhile: How can users be comfortably informed, and should this information occur in bursts, or in a stream?

FUTURE WORK

Most of the subjects in this study asked for an inverted principle: Silence, when nothing has happened – and a subtle, yet perceivable pulse after a missed event. This will be investigated in a future study.

Clearly, a long term study is needed, that examines the costs and benefits of permanent tactile actuation in mobile phones. What needs to be investigated as well is whether life-like movements are indeed more suitable in the proposed case than non-life-like movements. In this context, it would also be important to find out how the relationship to the device changes when it behaves like a living being.

It could also be thought of externalizing the actuator from the phone: Users that do not maintain body contact with their phone (e.g. when wearing it in a bag) would probably prefer an externalized version.

Ultimately, this project aims to create a ‘gut feeling’ for the phone; Users should not have to think about checking their phones. Until that point is reached, we face the ambiguity of silence in mobile phones: No news is no news.

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