Can You Feel It? – Using Vibration Rhythms to Communicate Information in Mobile Contexts

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Abstract. Development of interfaces for interaction in mobile scenarios faces the challenge of a broad variety of different possible user contexts. New approaches are needed, which demand a minimum of attention in situations where the user is engaged in other mobility tasks. In this paper, the results of an experiment targeting the recognition of vibration rhythms in real world mobile situations are depicted, suggesting further research on tactile mobile interfaces.

Keywords: HCI, mobility, tactile, perception, cognition, attention.

1 Introduction

Mobile devices are used in a broad variety of different situations – from sitting alone in a quiet café to engaging in a lively discussion with a friend while walking along a busy road. The cognitive resources being available for the interaction with a mobile application vary greatly depending on simultaneous mobility tasks [1]. Especially proactive services may interrupt users in mobile situations where their visual and acoustic senses are otherwise involved. In contrast, the tactile sense is often mainly unused. This is why using it to receive information in mobile scenarios is appealing.

Vibration rhythms offer an unobtrusive, socially acceptable possibility to use the skin as an additional channel for information. Allport *et al.* showed with their research from the early 1970's [2] that paying attention to information on multiple channels simultaneously is possible, if they use differing cognitive resources. In this paper, the results of an experiment are presented, which aimed at the recognition of vibration rhythms triggered by a wristband. In particular, it was looked for differences between a lab-condition and various typical mobile contexts.

2 Related Work

Tactile displays as a means of communicating information have been the topic of several studies. Brown & Kaaresoja [3] investigated the use of so-called “Tactons” to encode phone call information about caller and priority. In addition to different rhythms they used and compared the effectiveness of a vibration's “roughness” and “intensity”, respectively, for a second dimension of information. They used a mobile phone which was held in the hand. While the recognition rate of the rhythms was above 90%, the

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identification rates of priority encoded in roughness (55%) and intensity (75%) were not as high. As the experiment was solely conducted in a lab-environment, Brown and Kaaresoja suggest the investigation of recognition rates under real life conditions with the phone in a pocket and the user engaged in another task.

Among the approaches to assess the influence of real life mobile situations on recognition rates of tactile signals are experiments on a treadmill [4] and generic cognitive tasks in a controlled lab environment [5]. In contrast, an outdoor quasi-experimentation approach was utitilised for the experiment presented below, with the goal to simulate more realistic typical mobile use situations.

3 Experiment

Using tactile signals as a channel of information for everyday use requires a small, low-cost approach with generally interpretable tactile representations of low complexity. Pre-tests showed that using a mobile phone in a pocket is far from satisfying for recognising information through different vibration rhythms, because distinguishing between different kinds of vibration – if perceivable at all – was hardly possible. Additionally, lots of users don't carry their mobile phone in a pocket, but e.g. in their jacket, a bag, etc. To increase perceptibility, an approach with a fixed position of the vibration motor close to the user's skin was needed.

Inspired by devices like the BlueQ wristband[1] or mobile phone watches such as the M500[2], a prototype of a remote controlled wristband able to vibrate in different rhythms was built: An Arduino Nano microcontroller board, a bluetooth modem and a battery case were sewed into a stretchable wristband (fig. 1a). For the vibration, a LilyPad Vibeboard with a vibration motor running at a rated speed of 12000 rpm was sewed on the bottom side. Considering the recognition rates for intensity reported by Brown & Kaaresoja [3], the conducted experiment focussed on rhythm recognition.

Five different rhythms were selected for the experiments (fig. 1c). It is important to emphasise that these are not the result of a strictly systematic approach to find the very best rhythms but a sample suitable for the focus of this paper, which is to investigate situational influences on recognition rates. The utilised rhythms had been modified iteratively during pre-tests with colleagues from the lab until they showed to be discernable in a mostly distraction-free environment. For rhythm identification, numbers from 1 to 5 were used as generic identifiers. Identification rates when matching words or phrases to rhythms will be the focus of further research.

Fourteen persons aged 19 to 46 (avg: 26.2, sd: 8.4) volunteered for participation in the experiments. They were randomly assigned to either the experimental or the control group which were of equal size. First of all, a proband was primed, until she uttered she felt able to recognise the five rhythms.

Probands in the control group were asked to sit alone in a neutral room for 45 minutes and record perceived rhythms by pressing a button with the corresponding number on a PDA. The rhythms were randomly initiated at an average of every five minutes.

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[1] http://www.engadget.com/2007/05/18/blueqs-unsightly-vibrating-bluetooth-wristband/

[2] http://www.mymobilewatch.com/watch_specification.php

Probands in the experimental group had to walk a route unhurriedly with the help of printed cards which guided them from spot to spot and sometimes posed a task. At seven pre-defined spots on the route, the supervisor, who followed the proband (fig. 1b), initiated random activation of one of the five rhythms with a PDA wirelessly connected to the vibration wristband. The exact moment was randomly determined within a timeframe of ten seconds to minimize potential situational bias. The spots on the route were chosen to represent different typical kinds of real world mobile environments (quiet/noisy, calm/crowded) or activities (conversing, eating, messaging with mobile phone, checking bus connections). To avoid ordering effects, the direction of the route was randomly chosen for each participant.

The deployed design is a between-groups design with (lab/mobile)-environment as independent and recognition rate as dependent variable.

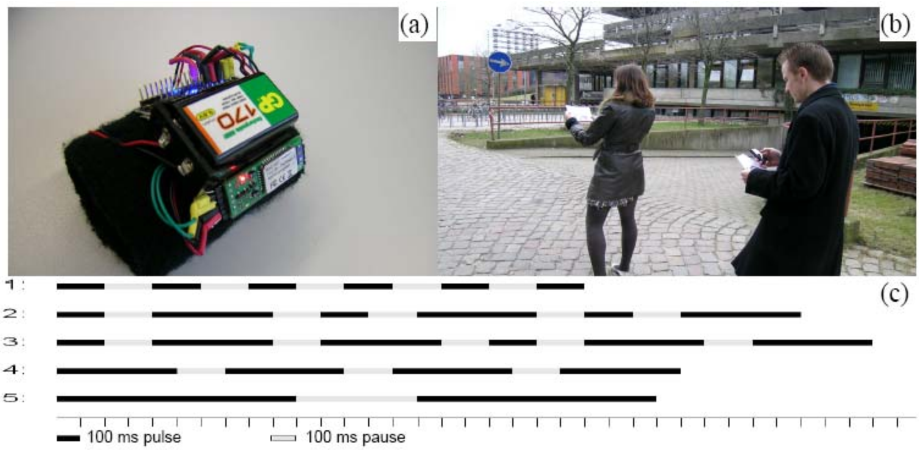

Fig. 1. (a) wristband prototype (b) navigating on mobile route (c) rhythms

4 Results

The main hypothesis was that the recognition rate in the experimental group would be lower than in the control group. A tendency for lower recognition in mobile contexts with a higher demand of cognitive resources was expected.

Interestingly, the recognition rate for both groups showed to be almost identical: After excluding the data of one proband, who failed to identify half of the rhythms in the control group (and was therefore treated as an outlier), the overall recognition rates were about 93% (sd: 11.5) in the control group and even 94% (sd: 16.2) in the experimental group. These results conform to those of Brown & Kaaresoja [3] for a mobile phone in the hand in a lab condition. As almost every rhythm was correctly identified by the probands in the experimental group, the data shows no significant differences between the selected situations. In both groups, no rhythm was completely missed.

According to Petrie *et al.* [6], negative effects of a mobile device result in a decrease of the user's walking speed. Although Preferred Walking Speed (PWS) was not explicitly used as a measure, it is worth mentioning that probands in the experimental group did not visibly slow down or even stop when perceiving a vibration rhythm while walking.

5 Conclusion and Future Work

Using a wristband capable of vibrating in different rhythms has promising potential to communicate information – even while users are busy with other tasks in real world mobile scenarios. Using a wristband instead of e.g. a mobile phone's own vibration motor seems to be able to bypass the problem of missing a vibration because of too much distance between vibration transducer and the user's skin.

Five different rhythms were quite easily discernable by most of the participants. Further research should closer investigate an optimal design for these rhythms and explore how capable users are of matching meaningful words or phrases to rhythms and what the best strategies are to support this. Moreover, a field test over a longer period of time, involving diverse real life mobile contexts would be valuable.

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