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The Fundamentals of Tactile Feedback Standardization for Consistent User Experience on Mobile Devices

Tomasz Gdala, Michał Gajewski
Samung R&D Institute
ul. Barniaka 88E/F (2nd floor), Poznan, Poland
t.gdala@samsung.com; m.gajewski@samsung.com

Grzegorz Olejniczak
Adam Mickiewicz University, Faculty of Physics
ul. Umultowska 87, Poznan, Poland
grzegorz.olejniczak@amu.edu.pl

Abstract – Paper presents the method that enables to provide consistent user interface in the terms of vibrational feedback perception on mobile devices. The method results in a pattern set that is device/hardware independent (i.e. users perceive signals similarly on wide spectrum of mobile devices). Authors are sure that proposed classification results in a background research for haptic feedback standardization.

***Keywords*:** Haptic feedback, User experience, User interface, Vibrations, Pattern building.

1. Introduction

The most important part of every mobile device is its user interface. The rule is simple – mobile device is as useful as its interface experience. There are three types of UI feedback communicated to the user: visual GUI changes, sound/voice (e.g. TTS like feedback) and tactile feedback (e.g. UI state can be communicated using vibrations). First two feedback methods are well covered by the tools typically used by designers.

The problem starts with the feedback using vibrations. Currently used solutions are the product of joyful engineer creativity, while that type of communication became extremely important especially for disabled users (e.g. those touched by low vision, blindness and similar).

Several authors investigated methods of communication with disabled people using vibrations (see Qian et al. 2011). In particular area of blindness authors spared no efforts to translate Brail language into vibrations (see Jayant et al. 2011).

The most important and currently recognized problems are as follows:

- The rate of information adoption (very low due to signal perception rate),
- Correctness (high possibility of mistake due to pattern similarities and vibrations generated by speakers and subjectivity of perception),
- Technical differences between mobile devices (different hardware solutions).

There is no standardized set of “vibration patterns” that results in a problem that two pre installed application may use the same vibration schemes to inform about entirely opposite behaviours (e.g. statements “error” and “ok” may have use the same vibration pattern). This obviously introduces confusion into the experience of disabled users.

The main goal of this paper is to present the method that enables to extract vibration patterns that are:

- Device independent (i.e. two different mobile devices can make use of them resulting in similar experience),
- Distinguishable (i.e. there is a small probability that two patterns cannot be distinguished),

- Meaningful (i.e. possibility to split them into groups of patterns recognized as kind, aggressive, etc.).

Authors of this paper are hoping that theirs work will enable designing consistent user interfaces creating fundamental for future standards. Moreover we would like to describe used methodology that anyone can expand into more specific areas of user interaction.

2. The Method and Results

Authors focused attention on vibration patterns that are from 500ms to 2 second long. Each pattern was divided into consecutive fragments of equal length (50 ms).

Each pattern fragment then is characterized by the state of vibration actuator. Number 0 means that actuator is turned off and number 1 that actuator is turned on. As a consequence patterns space contains from 1000 to over million different binary pattern representations (we could easily extend this to any arbitrary number of parts and their lengths).

Representation space is too big to be evaluated as a set of possible patterns.

Our method is using three consecutive steps that start with whole space of representationresulting in filtered space containing no more than about 40 of them.

Method steps are as follows:

- Combinatorial Filtering / Mathematics (enable us to select subset of patterns that are far from each other in the terms of Hamming distance),
- Physical property testing / Objective tests (use of vibration meter enable us to filer patterns that generate similar vibration waves),
- User survey / Subjectivity (enable us to classify patterns according to features perceived by the end users on variety of mobile devices).

First step of pattern evaluation needs combinatorial algorithm in order to find patterns that are relatively far from each other (in a pattern space equipped with Hamming like distance). After that step pattern space is decreased to about 10% of its nominal size.

The second step needs to exclude similarity in measured vibration wave generated by mobile devices. For the purpose of physical test we've selected 20 devices from different manufactures. All of the devices were tested using the laboratory table equipped with vibration meter. In addition vibrations generated by music and voice synthesizers were analysed. Measured values were normalized (signal energy normalization) resulting in vector space. We used vector clusters found in this space (equipped with proper norm) in order to find pattern representatives that are relatively far from each other (in the sense of signal difference).

That enable us to discover physical differences in mobile devices as a sum of their hardware and design (e.g. like actuator delays/propagation time, cover material propagation). We started with space filtered by combinatorial selection and then physical filtering results with 4% of the nominal space size.

Last step of our method is to make use of pattern set achieved applying first two methods. The volunteers using created survey (in the form of application) are asked to recognize 10 patterns picked uniformly at random from initial set. For each of them user is being asked to describe his perception of this signal in five categories, i.e.: smooth, aggressive, kind, long, short.

Response of the representative group of the users gives us possibility to finally classify collected, anonymous survey results. Resulting patterns set contain 44 patterns divided into five groups.

References

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