

Customized Vibration Patterns for Different Notifications

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Abstract

We performed a study to understand how mobile phone users perceive the urgency level by getting vibration alerts, and what is the upper bound of user to remember the patterns and comprehend the message by getting this vibration alerts. We created 12 different vibration patterns, each with different durations. Some of them are: “the short and long patterns correspond to 300 ms and 1100 ms”, respectively. To convey the level of urgency of notifications and help users prioritize them, the design of mobile phone vibration alerts should consider that the gap length preceding or succeeding a signal, the number of gaps in the vibration pattern, and the vibration’s duration affect an alert’s perceived level of urgency. Our results show which type of vibration pattern user mostly select and the upper bound for user is level 5 in which 5 patterns are randomized.

Introduction

Notification are the primary interface to the user that inform users about the status and activities of others. One of the key concerns in computer-supported cooperative work (CSCW) is to make the use of these interfaces, non-overwhelming or non-distracting to the users.

Vibrations are particularly important and are an essential component of the mobile phone notification system today. Vibration mode in phone is especially important when the user is busy in travelling or socially or user is within some meeting). While the vibration alert was typically used for signaling incoming calls and text messages in feature phones, in today’s smartphone, it can represent a wide array of notifications from numerous sources, ranging from games, location-based services, and communication-related applications.

we designed a practical vibration notification interface for an unmodified mobile phone by:

- a) Eliminating all features that are not currently supported by today’s mobile phone, including frequency, amplitude, and intensity.
- b) Testing the phone in the user’s hand instead of in other locations because while user study user has to click on button to randomize it.
- c) Three controllable factors affect the perceived urgency of basic vibration alerts in these types of phone: gap length, number of gaps, and vibration length.

A previous study by White [2] considered gap length a factor. This study used only a single gap length (with gap length vs. without) and was conducted using a customized adjustable tactile belt display system that is no longer available in current mobile phones. Thus, the results are not as relevant to today’s mobile phone users.

There was another study by NUS-HCI Lab [1] in which short and long gap lengths were used. As the study was done on basic 4 signals (short on, short off, long on and long off), as relevant to today’s mobile phone users. In this study we use different gap length.

As there are many types of Notification we get in day to day life. So, one plausible way to alleviate tactile modality crowding is by assigning a level of urgency for the incoming alert through the vibration signal itself. Vibration alerts can be interpreted and associated with different objects and concepts. So, we make some patterns which are common to every user. For example: Heart-Beat, Car-starting etc. as well as encoded with three urgency levels according to the designer’s preferences short (300, 100), Medium (800,300) and long (1100, 250).

Motivation:

In today’s time Mobile phones become an important part of us. It keeps us updated with the activities of others (family friends, office etc.). Even it keeps us updated with our surrounding. Some time we miss the important call, messages, Notification from office due to the following reasons:

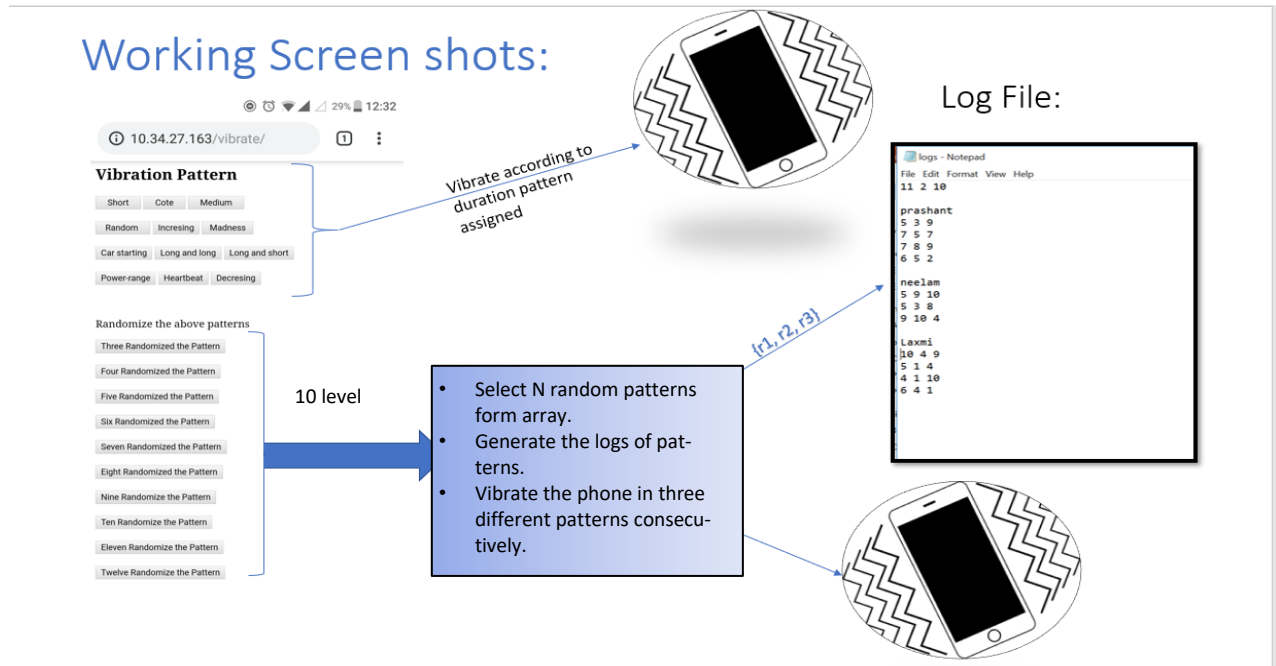


Fig 1: Web page design and Its working

- It is not possible for a user to keep mobile phones in hand all the time.
- User can't answer or see the important notification when they are in meeting, or out with friends or family.
- To cover the above two users, must carry or wear an extra gadget, which not possible for all.

To know which notification (call, message or text) is important to answer now and which notification can wait till later. It is important for user to set notification alerts. So, the vibration alerts are very important. Today in many smart phones different levels of vibration patters are introduced. So, it is very important to know answer of following questions:

- What kind of pattern a user uses most?
- Is it relevant to change the vibration patterns based on Duration?
- Are the users able to comprehend the message by getting the alerts or not?
- What is the upper bound of the user memory to remember the number of patterns?

Future design of mobile phones vibration alerts can leverage our findings to convey its degree of urgency and help them to use the upper bound of users' memory to understand and prioritize the incoming alerts.

Pilot Study:

We carried out a pilot study on two participants with ages ranging from 24 to 28 years to determine the appropriate lengths for vibration patterns. we confirmed that the appropriate lengths for short medium and long signals are 300 ms, 800 ms and 1100 ms respectively. We also confirmed that as we are using different gaps between patterns, we must relate them with some object and concepts.

Pattern Design

A vibration pattern is defined as an arrangement of the simplest repeatable alternating sequence of an actuator's on and off state, where on and off state is defined in term of time duration. for example, 1000 MS= 1sec.

As shown in figure1. We created a web page application, in which there are 12 different buttons, each for different vibration pattern. These vibrations are used by user during practice session and for assign the urgency level to different task.

To produce unique repeatable sequences. Each pattern is set with different duration and assigned different number of times to vibrate and pause within 2 sec. There are only two patterns used which have total time (vibrate +pause) more than 3 sec.

The second half part will be used for second experiment “find the upper bound of the user’s memory”.

- How many patterns a user can remember for short term?
- Whether the user can comprehend the message by getting the alerts or not?

When user will click on these buttons, it will perform following task:

- Select N random patterns form array of 12 patterns.
- Generate the logs of patterns with system date and time.
- Vibrate the phone in three different patterns consecutively with gap of 2sec between two consecutive patterns.

Table 1 shows the levels of vibration patterns.

Levels	Randomized patterns(N)
1	Generate 3 randomized patterns
2	Generate 4 randomized patterns
3	Generate 5 randomized patterns
4	Generate 6 randomized patterns
5	Generate 7 randomized patterns
6	Generate 8 randomized patterns
7	Generate 9 randomized patterns
8	Generate 10 randomized patterns
9	Generate 11 randomized patterns
10	Generate 12 randomized patterns

Table 1: The levels of vibration patterns

Pilot User Study:

Initially we recruit two users for study, both are graduate student with age between 24- 28 and have good experience with mobile devices and vibrate mode.

Goal: To know whether the users can remember and distinguish between the vibration pattern we used.

- Participants: 2(one female, one male)
- Task assigned: 2
 1. Task First: Map the patterns on 12 different notification and according to urgency.
 2. Task Second: Comprehend the message which by getting vibration alerts (Tested on only one level of pattern).

Result:

- Users were able to distinguish between the different patterns.
- Users are not able to remember the patterns in short period of time.
- Users were not able to comprehend the message, which they got by vibrating the device.

Evaluation (Final User Study)

Apparatus used:

We programmed a web page application on Dell Laptop using HTML, JavaScript, PHP, and jQuery. Used this application on an android phone. OnePlus2 smartphone running Android 6.0.1, Oxygen OS version, 4GB ram. The smartphone weighs 175gm and dimension- 151.8 x74.9 x9.8 mm. use Notepad file to store all the logs.

Design:

The Independent variable is the 10 different level of vibration pattern. And the dependent variables are Accuracy, User threshold to remember. The experiment is within subjects design. Here each user has to perform all the Task asked. Figure 2 shows: how long the pattern will vibrate and how long it will get pause It is graph between the duration and number of time each pattern will vibrate and pause.

Participants:

We recruit 12 participants (11 male and 1 female) with ages ranging from 23 to 30 years from five different nationalities.

Procedure:

At the beginning of the experiment, participants were briefed, and we gave them a demonstration of our app, for example: what are the patterns, related term we used, and what are the different level of randomized patterns at each level. We also briefed them about task second, while giving the demonstration (on level first) users was briefed about the work and how to comprehend each message.

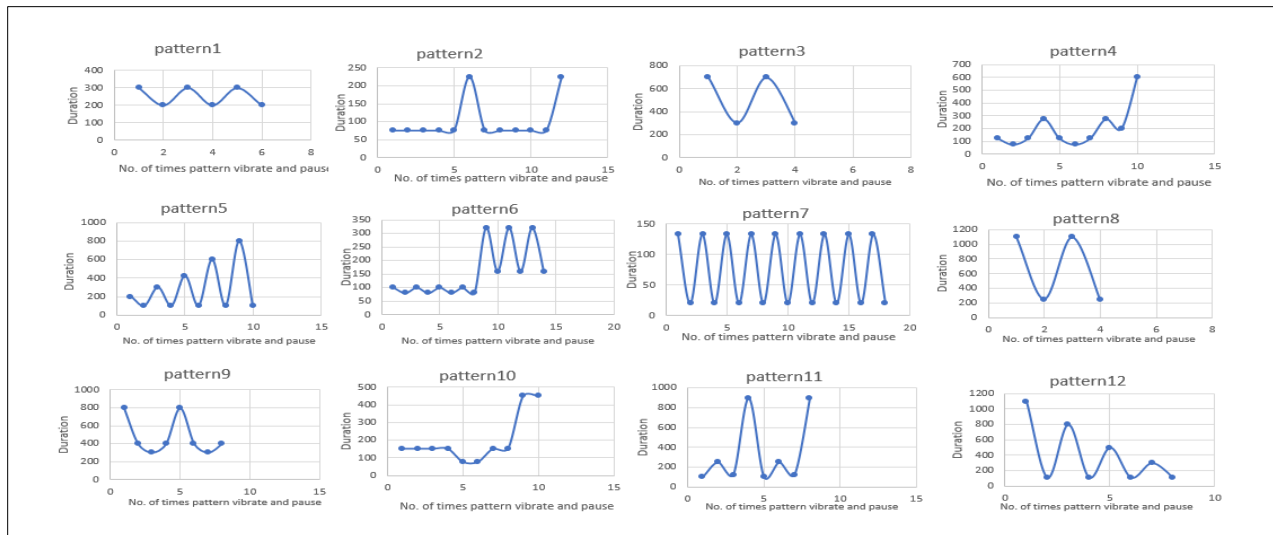


Figure 2: Design of 12 different patterns (Duration v/s Number of time pattern get vibrated and paused).

After that Participants were given time to practice and remember the 12 different patterns. They were asked to take 5 minutes to practice on the application.

After practicing, participants were asked to perform following Task:

- Task 1: Assign the vibration pattern to different Notification according to urgency.
- Task 2: Comprehend the message according to vibration on 10 different levels.

In task second, at all levels more than two vibration patterns will vibrate consecutively with gap of maximum 2sec between them.

Metric Used = $12 * 2 * 10$ (12 participant each performing two tasks on 10 different levels).

After, user complete their both tasks, for their feedback I give them a small questionnaire. They were asked to answer some question about their experience with the application and study.

Results

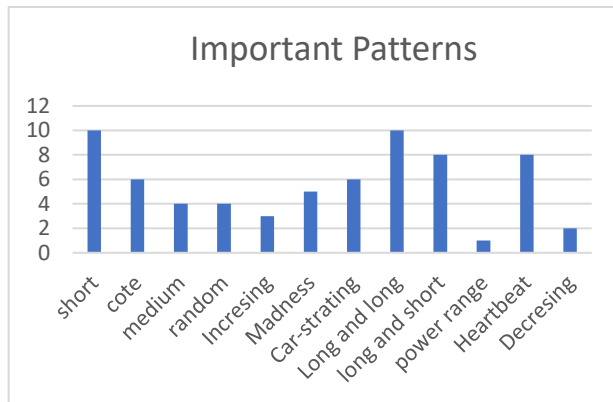


Figure 3: Vibration patterns used by user for setting urgency level.

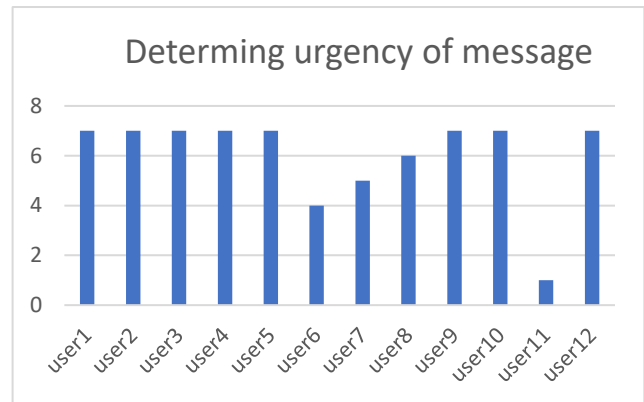


Figure 4: Users feedback

Task 1: Here users, after practicing on pattern for 5 minutes. They set different vibration according to urgency they want to perceive. Figure 3 shows that:

- Most of the user select Short, long and long, Heartbeat and long and short as the important vibration, they want to use for urgency level.

- Figure 4 is the result from the feedback of the users after completing the both tasks. Here, we can see that most user find this vibration patterns good for determining the urgency of message.

Task 2: We performed this study and task to answer these questions:

- Are the user's able to comprehend the message by getting alerts or not?
- what is the upper limit of user's memory?
- Are they able to memorize all 12 patterns for short term? If not, what is the upper bound of the patterns they remember?

Figure 5 shows the result of the correct messages comprehended by user at different level.

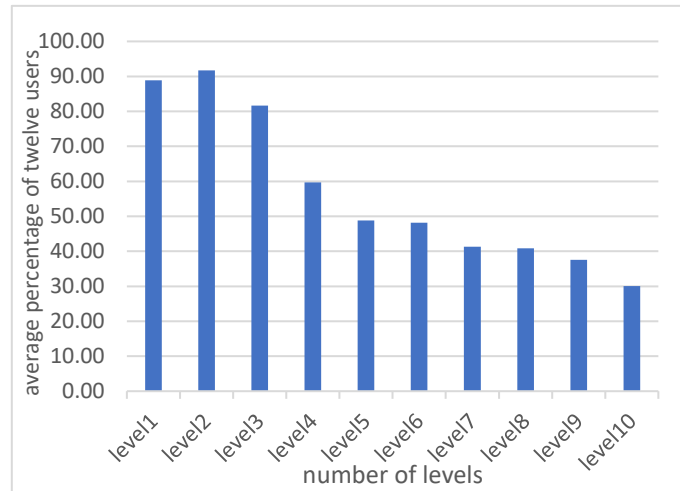


Figure 5: Average of correct message comprehended.

Here we can see that:

- Most of the user correctly comprehend the message till level 3.
- Which give us an insight that may be till level 3 (Till 5 randomized patterns) user are able to recognize most of the patterns.
- Are they able to memorize all 12 patterns for short term? If not, what is the upper bound of the patterns they remember?

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During this Study we notice that some users are able to recognize some patterns even when 12 patterns are randomized. Reasons are:

- Some patterns are easy to remember and distinguish even in the mixture of large patterns.
- Users can recognize the patterns easily which they used to set the urgency level.

Discussion

The above result shows that, the short and long and their combination is used as important pattern by most user. It can also be said that patterns which user can related to objects or concepts are proved as important vibration patterns.

Where as result of task 2 shows that the upper bound for a user to comprehend and remember out of '12' patterns are '5'. Some user also performs good at later level, but they mostly recognize patterns only which they assign to perceive the urgency.

Future Work

There is some limitation of our work based on users comment:

- We can use a smaller number of vibration pattern.
- Some patterns are more confusing when they are vibrating consecutively.
- Some users commented that we can use more gap duration between the two patterns when we are randomizing them.

The future work can be done on this project, we can use a smaller number of vibration and permute the duration to make some new patterns. To improve the work further we can assign more duration gap only for study purpose.

References

1. “Designing an Effective Vibration-Based Notification Interface for Mobile Phones” Baha or Saket, Chrisnawan Prasajo, Yongfeng Huang, Slihengdong Zhao (NUS-HCI Lab, School of Computing, National University of Singapore, 2013)
2. White, T. The Perceived Urgency of Tactile Patterns. Human Research and Engineering Directorate, Army Research Laboratory. ARL-TR-5557 (2011)