

Snap-Crackle-Pop: Tactile Feedback for Mobile Touch Screens

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ABSTRACT

This paper describes a mobile device demonstrating tactile feedback for touch screens. The demonstrator includes four different applications: keypad, text selection, scrolling, and drag and drop.

Keywords: mobile devices, tactile feedback, touch screen

1 INTRODUCTION

The small screens on mobile devices and the fact that they are used in dynamic mobile contexts mean that visual feedback alone is often insufficient. Current touch screen devices often feature audio feedback in response to user actions, but tactile feedback is rarely included. Adding tactile feedback to touch screens has the potential to improve usability by providing additional feedback to the user, e.g. confirming that a button has been pressed. This may be particularly beneficial in noisy environments, where audio feedback would not be heard. In addition, tactile feedback could improve the user experience by making virtual widgets feel more like real physical widgets.

This paper presents a mobile device with a touch screen enhanced with tactile feedback, and discusses four demonstration applications – keypad, text selection, scrolling, and drag and drop.

2 RELATED WORK

Research on tactile feedback for touch screens has previously been carried out by a number of researchers. Fukumoto [1] used a voice coil actuator mounted in the body of a device to provide single pulse tactile feedback to the finger when buttons on a numerical keypad are pressed. Nashel and Razzaque[2] used a vibration motor from a tactile mouse to provide information to users about the buttons on a PDA screen. Poupyrev et al. [3, 4] have carried out extensive research in this area. They added proprietary piezo actuators between the touch screen and the resistive touch panel. They added tactile feedback to multiple GUI elements and introduced a structure for gestures in touch screen. They also introduced speed dependent tactile feedback for scrolling a document by tilting a device. Although the continuation of their work focuses on desktop touch screens [5], it is still relevant for mobile devices. They conducted a tapping study with a stylus, and introduced a text selection feature enhanced with tactile clicks for each character. They also found that tactile feedback is most effective when combined with an active gesture, such as dragging, rather than just being used to enhance a simple tap.

3 DEMONSTRATION

The demonstrator is a proprietary mobile device, called “Snap-Crackle-Pop”, which is connected to a laptop via two cables, one for transferring the display to the device and the other (a

serial cable) for transferring the data related to the touch screen. The applications are written in Java.

Off-the-shelf piezo actuators are located under a resistive touch screen, and provide tactile feedback to a stylus or finger using the device and to the holding hand. The details of the technology of this demonstrator are beyond the scope of this paper, which focuses on the user interface elements of the system.

Tactile feedback has been added to four different applications: numerical keypad, text selection, scrolling, and drag and drop. Based on Poupyrev’s finding that tactile feedback is most useful when used to enhance gestural interactions, three out of these four applications use gestural interaction; only the keypad application uses a simple tapping interaction. Within each application it is possible to switch the different types of tactile feedback on or off, and to customize the strength of the tactile feedback.

The applications presented in this paper are based on the previous work, but also extend the scope of what has previously been done. For example, the text selection demo is based on the text selection design by Poupyrev, but features tactile feedback for line selection in addition to character selection. The scrolling demo is based on the speed dependent scrolling application by Poupyrev, but the interaction uses touch screen gestures instead of tilting. Finally an entirely new application of tactile feedback is presented, with the addition of tactile feedback to the different phases of the gestural drag and drop interaction.



Figure 1 The demonstrator device, displaying the keypad demonstration application.

4 KEYPAD DEMONSTRATION

The keypad demonstration application shown in Figure 1 is a virtual ITU-T number keypad with the device in portrait

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mode. The buttons are designed to be pressed with a thumb or a stylus. When a button is pressed the color of the button changes and a tactile click is presented; when it is released the color changes back to the original and second tactile click is presented to the user. This tactile feedback is designed to simulate the real tactile feedback experienced when pressing a physical button.

4.1 Text selection Demonstration

In the text selection demonstration a text document is displayed on the screen (Figure 2) and tactile feedback is presented to the user when text is selected. The device is used in landscape mode for this application. When the user selects the text by dragging horizontally, a gentle tactile click is presented as each character is selected. If the user drags vertically to select line by line, a stronger tactile click is presented for every line indicating that more text has been selected. The addition of tactile feedback to the text selection task is intended to improve targeting and enable more precise text selection.

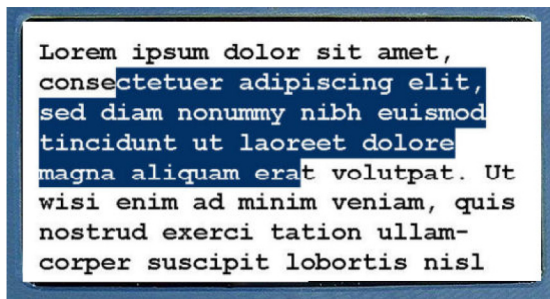


Figure 2 Text selection demonstration with some text selected.

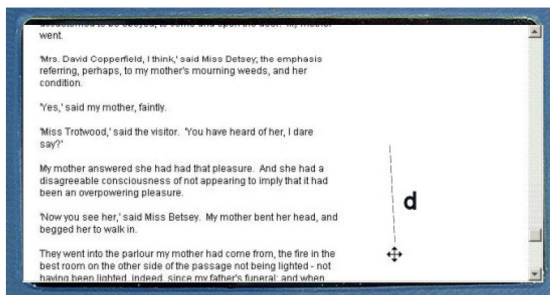


Figure 3 The scrolling application. The path of the stylus is shown with dashed line. The speed of the scroll is proportional to the distance (d).

4.2 Scrolling Demonstration

In the scrolling demonstration speed dependent scrolling is enhanced with tactile feedback in order to indicate the current scrolling speed to the user non-visually. In the demonstrator application a large document is displayed on the screen. The user can enter the scrolling mode by pressing the stylus onto the centre of the screen and holding it still until tactile feedback is presented. This tactile feedback indicates that the user has entered the scrolling mode. The user can then scroll up and down through the document by moving the stylus up and down, respectively, while holding the stylus on the screen. The scrolling speed is proportional to the distance of the stylus from the initial point (Figure 3). As the user scrolls through the document tactile clicks are presented, with the frequency of occurrence of the clicks being proportional to the scrolling speed. The user can leave the scrolling mode by simply lifting the stylus off the screen. When the scrolling mode is not engaged this application features the tactile feedback from the text selection demo.

4.3 Drag and Drop Demonstration

Tactile feedback was added to drag and drop operations in order to improve targeting, enhance the feel of the “dragging” action, and help to confirm user actions by providing different tactile feedback when a document is hit to or dropped onto different items. In the demonstration there are three graphical icons on a desktop in this demonstration application. One of them, a text document, is movable and the user can pick it up by holding the stylus on it for a while in the similar manner than entering the scrolling mode in previous demonstration. The user can drag the icon by moving the stylus while holding it on the screen.

Seven different types of tactile feedback are presented to the user in this application for the following actions (Figure 4):

1. When the user picks up the text document icon.
2. When the user drags the object on the desktop.
3. When the user hits the folder object
4. When the user hits the word processor object
5. When the user drops the icon onto the desktop
6. When the user drops the icon into the folder
7. When the user drops the icon onto the word processor application and the application opens the text document.

5 CONCLUSIONS

This paper describes the “Snap-Crackle-Pop” device demonstrating tactile feedback in touch screen applications for mobile devices. The addition of tactile feedback to mobile device touch screens has the potential to improve both the usability and user experience of such devices. Future work will investigate the effect of this tactile feedback on user performance and experience in the different tasks featured in this demonstration.

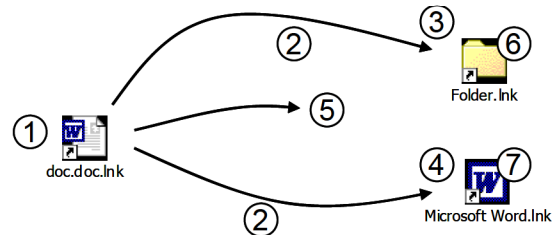


Figure 4 The cases when the user gets different tactile feedback in drag & drop application.

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