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Design and Development of Haptics Solutions for Touch Sensitive Mobile Devices

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Abstract— Touchscreens have been invading mobile devices all over the world and they are replacing traditional user interfaces. Since the users are unaware of the mechanical button feedback of touchscreen, which the user can feel while operating the device. The major disadvantage of touch screens are no physical or mechanical feedback when the touchscreen is pressed or an event occurs and even absence of haptics feedback. Haptic technology is the future of touch interface, which allows the user to not only touch the screen but also feel the texture on their fingertips. The proposed project is aimed to generate more delicate haptics sensations on the touch panel, various piezo actuators were incorporated into mobile devices. Piezo actuator generates haptics sensations for various UI (User Interface) tools and touch events triggered. This paper explains about the design and development of haptics solutions for touch sensitive mobile devices at Motorola solutions. This involves MPA 2.0 BigBoard, piezo actuator and DRV8662EVM haptic driver modules.

Index Terms— Actuator, Haptic driver, Haptic Feedback, I2C Interface, MPA 2.0 BigBoard, Multi-model, Soft Input Panel.

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1 Introduction

Touchscreens are rapidly evolving as the preferred interface in mobile devices with dynamic and contextual user interfaces driving advanced device functionality. While touchscreens offer massive benefits by allowing for these dynamic interfaces, the lack of haptics response on traditional touchscreen devices results in no mechanical and physical feedback.

Current developments in haptics technology are promising to open up new areas in the communication and display industries. It also presents various prominent haptics actuators and related mobile applications [1]. Haptics is being used with increasing frequency in mobile devices to restore the sense of physical sensations within a digital device. Applications of haptics have extended beyond traditional button confirmation to include gaming effects, alerts, and multi-modal UI elements that layer haptics into visual and audible feedback to create a more contextual and realistic user experience [2],[3].

Previous research by Hoggan et al. [4] showed that adding simple haptic feedback for touchscreen interactions significantly improved typing performance. We extended this feedback to use different tactile cues to change the feel of the touchscreen [5]. It generates tactile cues to alert user for a specific attention. Alert while typing wrong word as per dictionary and gives different sensations for virtual keys and button user interface. It also alert user typing alphabets when focus is lost in edit box and also check for battery status by pressing a button [6],[7].

There are several studies to provide a richer user experience using tactile feedback and audio effect. Menelas [8] showed that the combination of audio and haptic cues is very helpful to reach the target in a virtual environment.

We extend this haptic feedback to generate different of haptics alert for GUI (Graphical User Interface) tools such as button user interface, scroll bar user interface and soft input panel in touchscreen mobile devices [9],[10].

2 Scope of Work

The scope of the work is:

- To resolve lack of haptics feedback in touch sensitive mobile devices and provide a realistic user experience.
- To establish the mobile devices to generate the haptics sensations when the user touches the touchscreen or an event occurred.
- To explore the benefits of haptics that can improve task performance, increase user satisfaction, and user makes less error prone while typing.

3 Haptic Feedback System

The modules of haptics feedback system are MPA 2.0 BigBoard, DRV8662EVM haptics driver and Piezo actuator driver in Fig 1. MPA 2.0 BigBoard is a platform builder integrated with the processor and peripherals to develop the application for Motorola enterprise devices. Actuator generates different haptics sensations based on the input waveform's voltage and frequency.

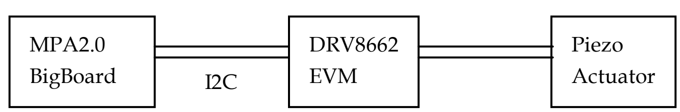

Fig 1 Haptic Feedback System.

An interface between BigBoard and DRV8662EVM modules is I2C bus. I2C Bus (Inter-Integrated circuit) is easy to use to link multiple devices together since it has a built in addressing scheme. It has two signals one is SDA (serial data) and another

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is SCL (serial clock).

The evaluation module contains the DRV8662 piezo haptics driver, an MSP430 microcontroller, and passive components for complete evaluation in Fig 2. Detailed methodology of DRV8662EVM is explained in section 4.

Fig 2. DRV8662EVM haptics driver module.

4 METHODOLOGY

Touch driver register the touch events when user touching the touchscreen of MPA 2.0 BigBoard. Updating touch driver to send registered touch commands to the haptics driver. The haptics driver is implemented to generate different types of haptic alerts. I2C driver is been used for communication between the MPA 2.0 BigBoard and DRV8662EVM haptics driver evaluation module. Touch driver, haptics driver and I2C driver is the part of the MPA 2.0 BigBoard processor and peripheral devices.

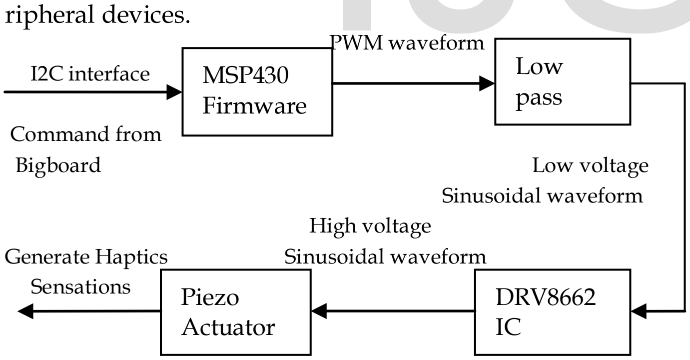

Fig. 3 DRV8662EVM detailed procedures.

Haptics driver issues commands to "DRV8662EVM" based on the type of touch (For example Key click, scrolling a list and button click etc.) In original firmware, added support for I2C interface, which controls and provide an input signal for the DRV866EVM (MSP430). The haptics driver module is implemented to generate various haptics alerts and then these are sent to MSP430 firmware.

The MSP430 can be programmed to create unique functionality and custom haptics effects. It is 16-bit processor designed for low power application. The firmware generates pulse wave signals these are sent to the low pass filter that transforms the PWM carrier waveform into low voltage sinusoidal waveform. This transformation is achieved by low-pass filtering the PWM carrier waveform which is at a frequency typically 20 kHz or great. Voltage booster DRV8662 IC converts these sinusoidal waveforms to high voltage sinusoidal waveform (50V-200V) in Fig 3. Then high voltage signals are passed to the piezo actuator to actuate and give sense of touch to the user. Actuator generates different haptics sensations based on the input waveforms voltage and frequency.

Microsoft visual C++ is an integrated development environment (IDE) used for the development of the haptics application and GUI design by using Windows API. These applications are run on the Windows CE Platform builder. IAR work bench is an IDE used for implementing MSP430 Firmware. Windows CE as a programming language.

5 EXPERIMENT ANALYSIS AND RESULTS

The touchscreen displays the GUI of the haptics application and soft input panel (SIP) of the mobile device. This screen will appear when the application starts. User needs to enter the username and password to login for haptics application. SIP which is appeared on the screen is provided with the haptics feedback. When the user presses virtual key it will give sense of touch to the finger that key was pressed in Fig 4.

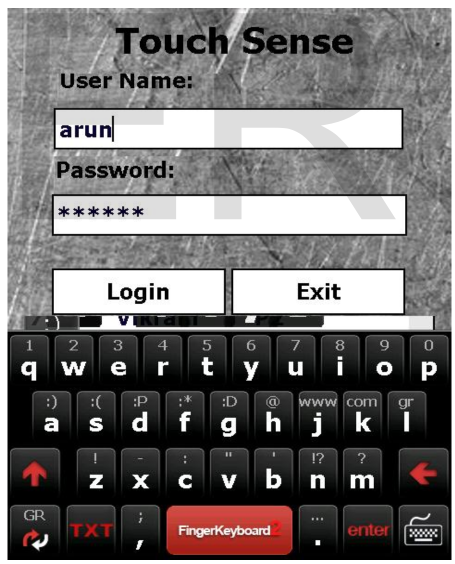

Fig. 4 Soft Input Panel with Haptics feedback.

Once the user is logged into haptics application, then it comes to the button user interface screen of haptics application with delivery button, pickup button and battery status button of the application in Fig 5, the screenshot shows the pressed battery status button and it generates the number of haptics alert based on the status of available battery in the device.

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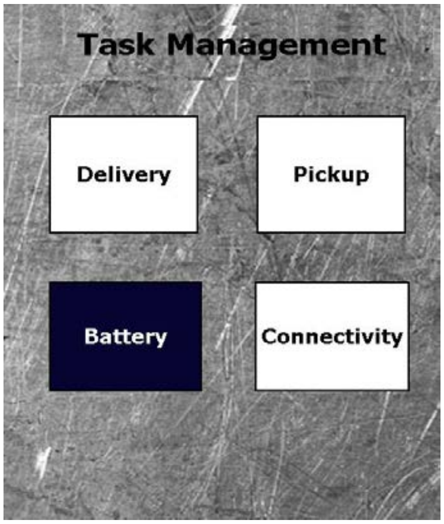

Fig 5. Button click user interface of haptics application.

When user presses the pickup or delivery button then it will gives the button click sense to the user and then comes to next window that contains the list of customers, serial no, and priority information in Fig 6. The scroll bar will gives the rumble effect when the user scrolling the list and generates the priority alert if high priority message comes in between.

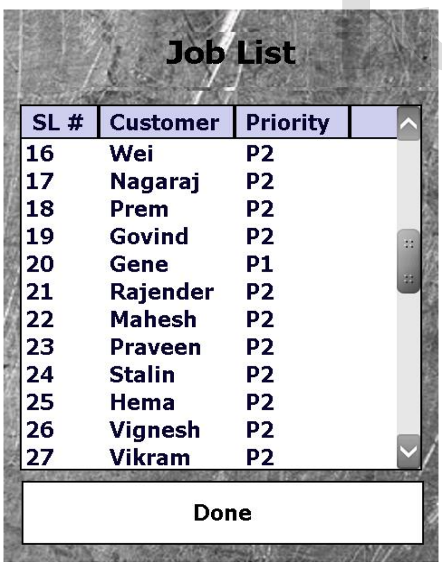

Fig. 6 Scroll bar User Interface generating rumble effect.

The Fig 7 shows the message box and signature box of haptics application. When user enters message, it will appear in the message box and if they enter wrong words as per the dictionary it will generate the haptics alert to the user. The user enters a word such as mobiile instead of a word mobile in such a case it generates the haptics alert indicating that wrong word is entered.

Fig 7. Haptics alert generation for typing wrong word.

6 Conclusion

Piezo actuator haptics feedback reminded user of using mechanical button and user could feel what they was pressing. Piezo actuator haptics feedback is accurate and pleasant to use. The haptics feedback makes user need not to guess did the device receive my key press or not. The user just felt the sense of touch and this could improve the input performance of the touch screen devices. It was found that piezo feedback not only improves the user performance but it also leads to a more satisfying experience in touchscreen interaction.

Haptics feedback generates the tactile cues to alert user for specific attention for example; Alert while scrolling down the list of items and high priority information comes in between. Generates different sensations for SIP, Button press and alerts user typing alphabets when focus is lost in edit box and can also check for battery level.

References

[1] A.Yamamoto, S.Nagasawa, H. Yamamoto, and T. Higuchi, ”Electrostatic tactile display with thin film slider and its application to tactile telepresentation systems” *IEEE Trans. Visual Comput. Graph.*, vol. 12, no. 2, pp. 201–207,2006.

[2] Dong-Soo Kwon1, Tae-Heon Yang1, JoonYeon Cho1 ”Trend & Prospects of Haptics Technology in Mobile Devices” *IEEE/ASME Trans. Mechatronics*, vol. 8, no. 3, pp. 280-288, 2002.

[3] Tim Blankenship, Product Definer ”Tactile Feedback Solutions Using Piezoelectric Actuators” *IEEE Trans. Touch Interface Products, Maxim Integrated Products Inc*, vol 7, no 5, pp 23-45, 2010.

[4] Hoggan, E, Brewster, S.A. and Johnston J ”Investigating the Effectiveness of Tactile Feedback for Mobile Touchscreens” *In Proceedings of ACM CHI2008. ACM Press*, pp 1573-1582, 2009.

[5] Stephen Brewster and Aurora Constantin “Tactile Feedback for Ambient Awareness in Mobile Interactions” *Glasgow Interactive Systems Group, Department of Computing Science University of Glasgow*, Glasgow, G12 8QQ, UK, pp 23-31, 2011.

[6] Tim Blankenship, Product Definer ”Tactile Feedback Solutions Using

Piezoelectric Actuators" *IEEE Trans. Touch Interface Products, Maxim Integrated Products Inc*, vol 7, no 5, pp 23-45, 2010.

[7] Varalakshmi B D 1, Thriveni J 2, K R Venugopal 3, L M Patnaik, " Haptics: State of the Art Survey", *IJCSI International Journal of Computer Science Issues*, Vol. 9, Issue 5, No 3, page no 234-340, September 2012.

[8] Jeong-Mook Lim†, Jong-Uk Lee†, Ki-Uk Kyung† and Jae-Cheol Ryou "An Audio-Haptic Feedbacks for enhancing User Experience in Mobile Devices" IEEE international conference on consumer electronics, Chungnam National University, Daejeon, Korea, DOI:978-1-4673-1363 -6/13, pp 49-50, 2013.

[9] Hiroaki NISHINO , Ryotaro GOTO, Tsuneo KAGAWA, Kazuyuki YOSHIDA "A Touch Screen Interface Design with Tactile Feedback" International *Conference on Complex, Intelligent, and Software Intensive Systems*, ISBN: 978-0-7695-4373-4, pp.53-60, 2008.

[10] Varalakshmi B D 1, Thriveni J 2, K R Venugopal 3, L M Patnaik, " Haptics: State of the Art Survey", *IJCSI International Journal of Computer Science Issues*, Vol. 9, Issue 5, No 3, page no 234-340, September 2012.