LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

LFE Medieninformatik • Cun Sun

Abschlussvortrag der Diplomarbeit

Tactile Feedback for Touch-sensitive Surfaces

Verantw. Hochschullehrer:
Prof. Dr. Heinrich Hußmann
Betreuer:
M.A. Yuanting Liu (Siemens),
Dipl.-Medieninf. Sebastian Boring

28.07.2009

Tactile Feedback for Touch-sensitive Surfaces

Cun Sun
suncu@cip.ifi.lmu.de

Introduction
- Motivation
- Goals of the Thesis
- Related Work

Realization
- Hardware configuration
- Software Interface
- Design Concept and Prototype

Evaluation
- User Study
- Results
- Summary

Cun Sun
suncu@cip.ifi.lmu.de

Motivation

- Touchscreens are widely used. (e.g. ATM, Kiosk)

- New devices are equipped with both touchscreen and actuators ready to create tactile feedback. (e.g.Samsung SCH-W559)

- Tactile feedback could be used to make a virtual object “feel” more real. (e.g. Virtual keyboard)

- Tactile feedback could be used to provide information instead of visual or auditory feedback. (e.g. Eyes-free use)

Cun Sun
suncu@cip.ifi.lmu.de

Goals of the Thesis

The thesis will focus on using tactile feedback for UI elements such as buttons, switches, sliders, etc. on a touchscreen.

The results are:

1. Building the hardware configuration of a tactile touch screen prototype.
2. Development of the interface between hardware prototype and software application.
3. Design and implementation of tactile UI elements.
4. Evaluation of the built tactile UI elements.

Cun Sun
suncu@cip.ifi.lmu.de

Related Work

Different parameters for tactile feedback [1][2][3]

- Duration, frequency, amplitude, rhythm, waveform

Tactile Feedback applied on different input events[4][5][6][7][8]

- Finger moves into a button, Finger is over a button, Finger moves out of a button, Finger pushes a button

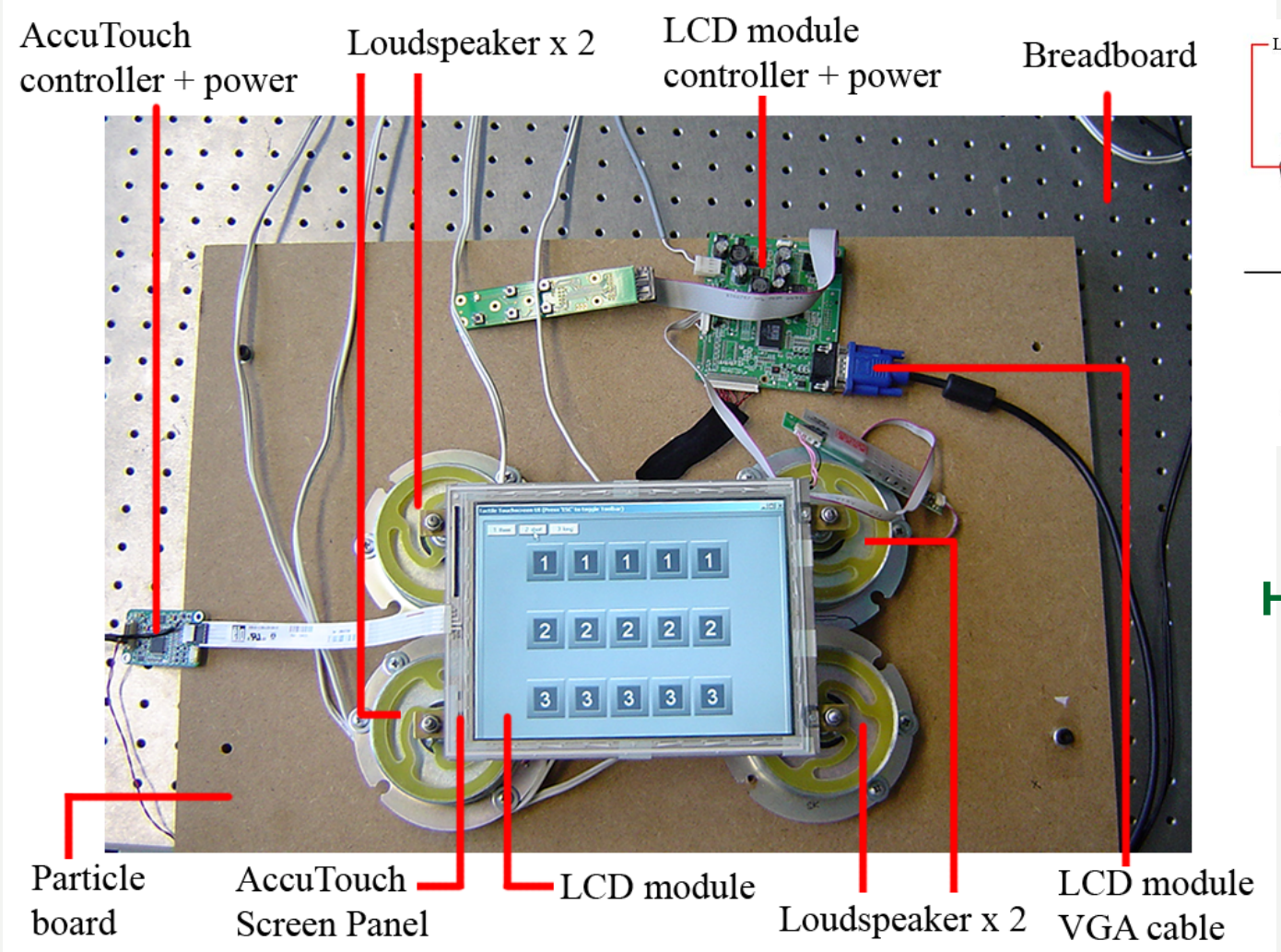
Tactile Feedback applied on different tasks[9]

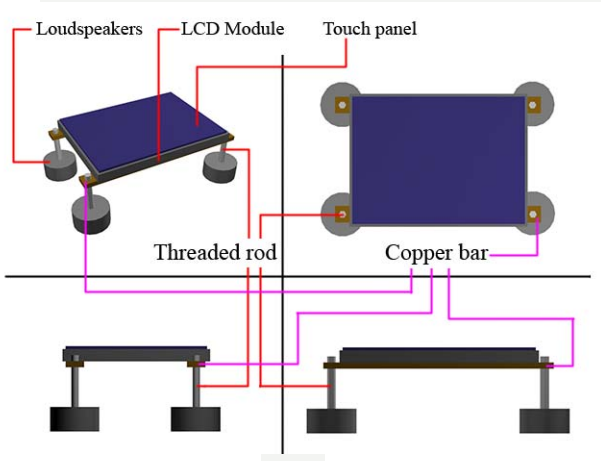
- Button Task, progressbar Task, scrollbar task

Tactile Feedback for Touch-sensitive Surfaces

Cun Sun
suncu@cip.ifi.lmu.de

Hardware configuration





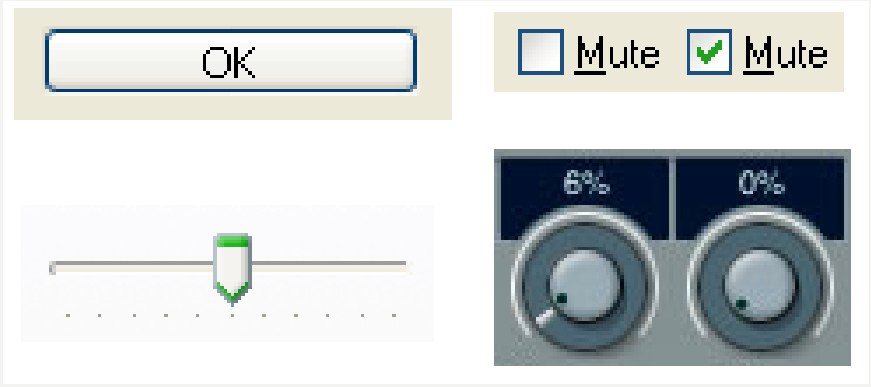
Hardware setup

Cun Sun
suncu@cip.ifi.lmu.de

Software Interface

- Programming language: C#
- Tool to create tactile feedback: CoolEdit Pro
- Additional library for audio playback: irrKlang

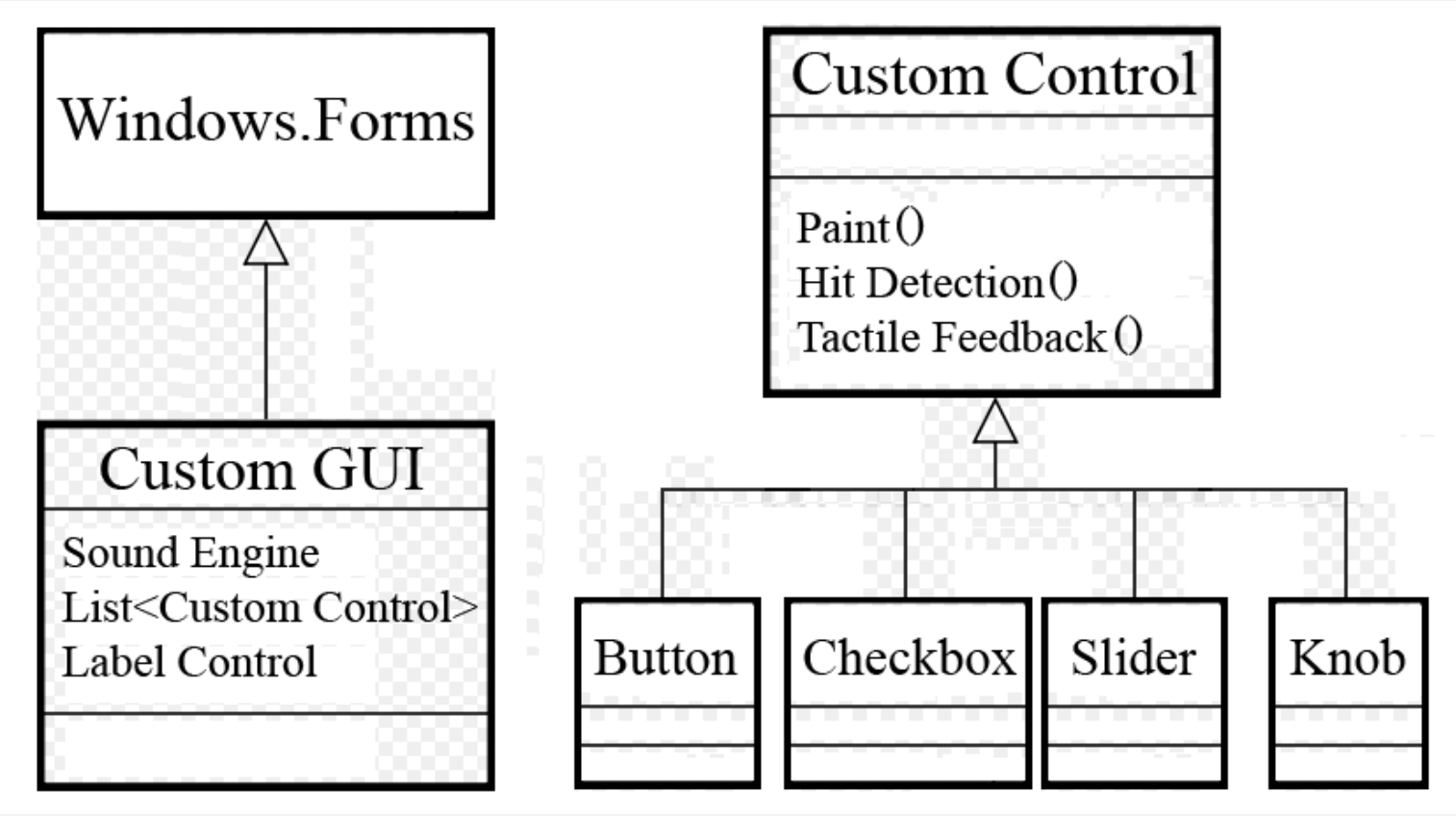
- Implemented UI elements: Button, Checkbox, Slider, Knob



- Supported touchscreen input events:
Mouse Up, Mouse Over, Mouse Down, Mouse Enter, Mouse Leave, Mouse Drag

Cun Sun
suncu@cip.ifi.lmu.de

Software Interface



UML Diagram

Cun Sun
suncu@cip.ifi.lmu.de

Design Concept and Prototype

- Experiment Part One: „Realness“ of tactile feedback

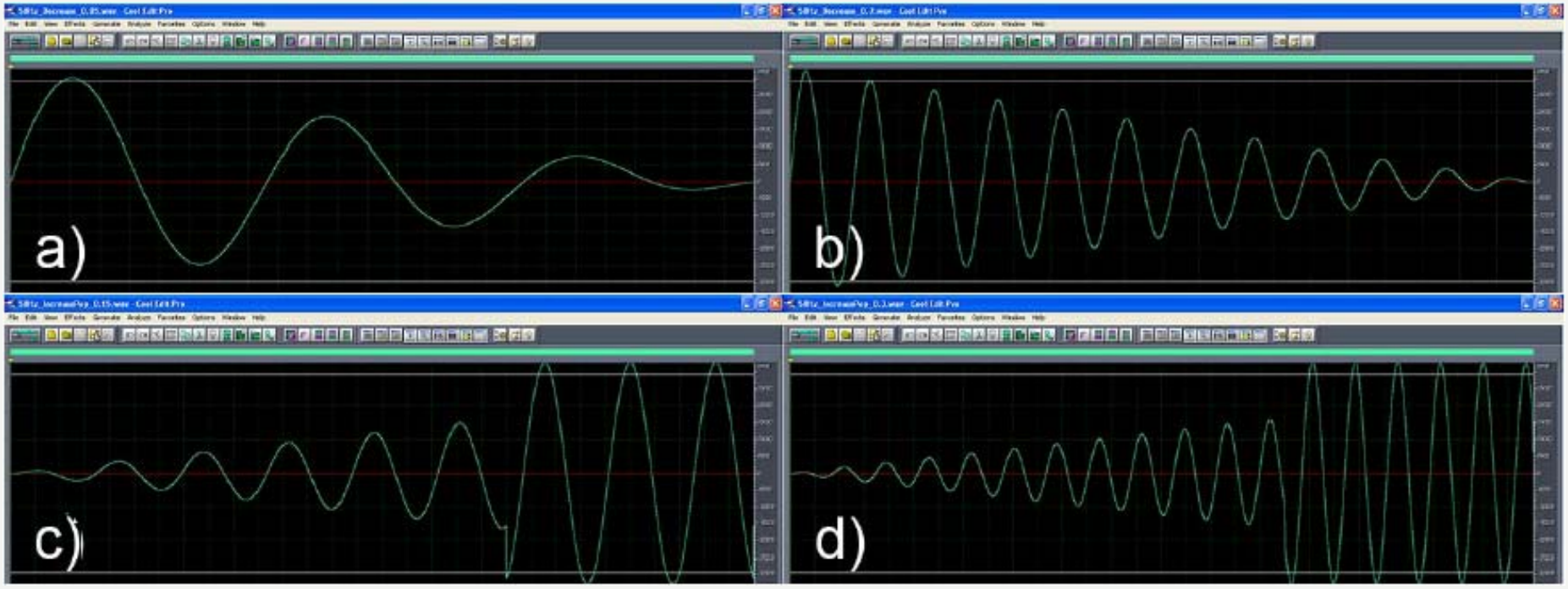
- Experiment Part Two: Tactile feedback on different events

- Experiment Part Three: Tactile feedback in an imaginary UI

Cun Sun
suncu@cip.ifi.lmu.de

Experiment Part One

- Parameters for Button
Duration, frequency, amplitude change (inceasing amplitude and decreasing amplitude) and an intense impuls at the end of the feedack.

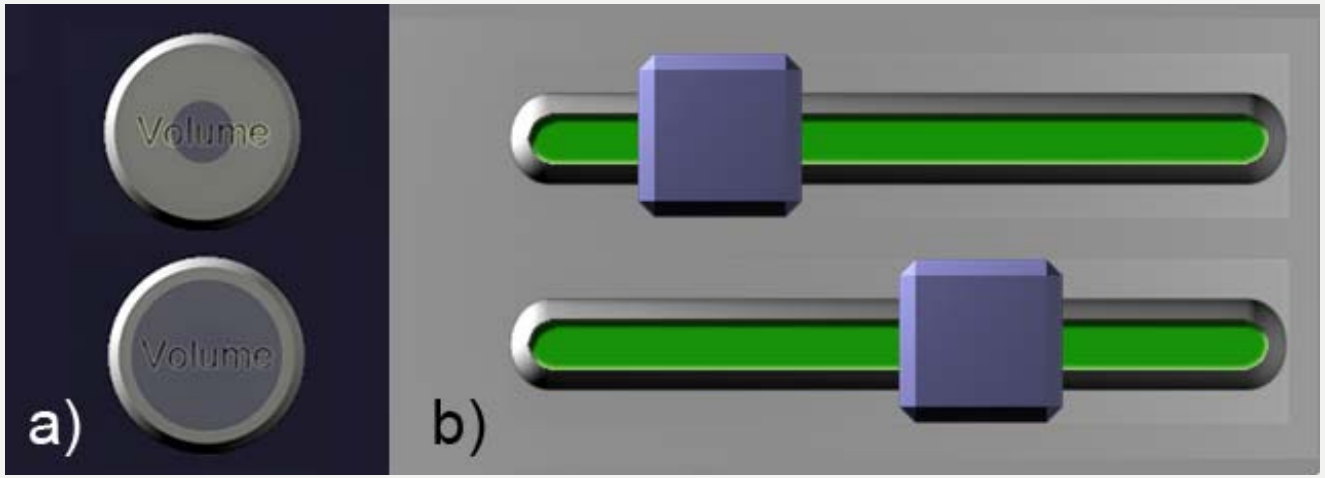


Tactile feedback with different parameters

Cun Sun
suncu@cip.ifi.lmu.de

Experiment Part One

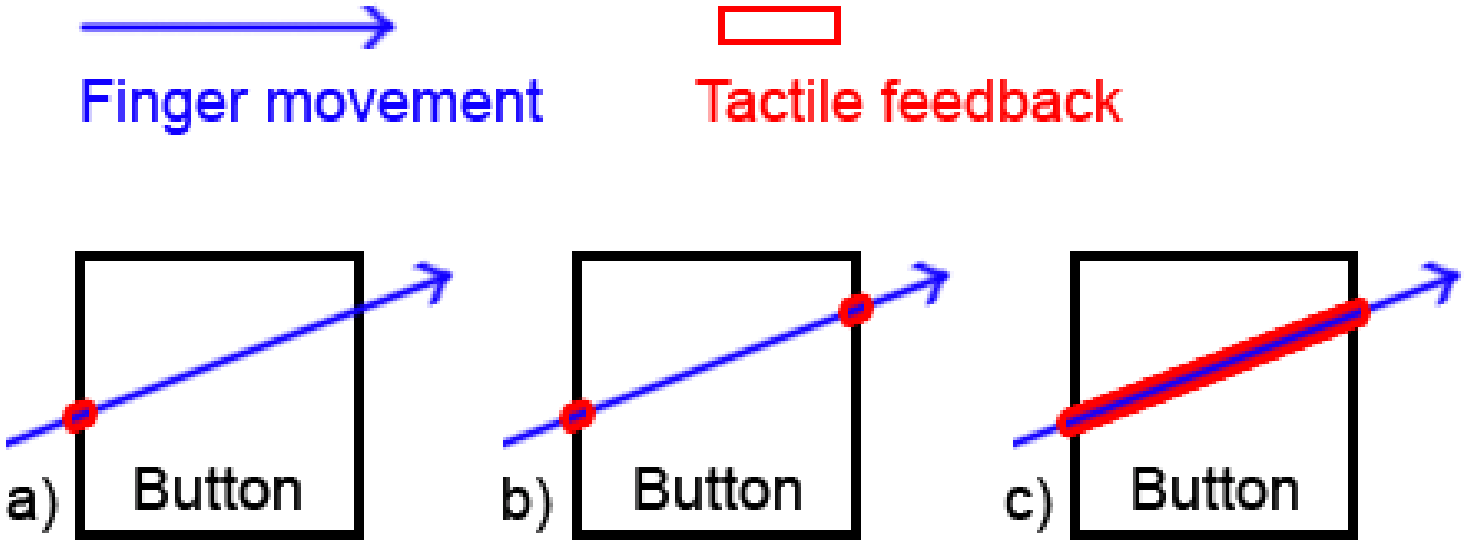
- Parameters for Sliders and Knobs
Changing frequency, changing amplitude and tactile feedback at discrete values



UI elements in the experiment
a) Knob
b) Slider

Cun Sun
suncu@cip.ifi.lmu.de

Experiment Part Two

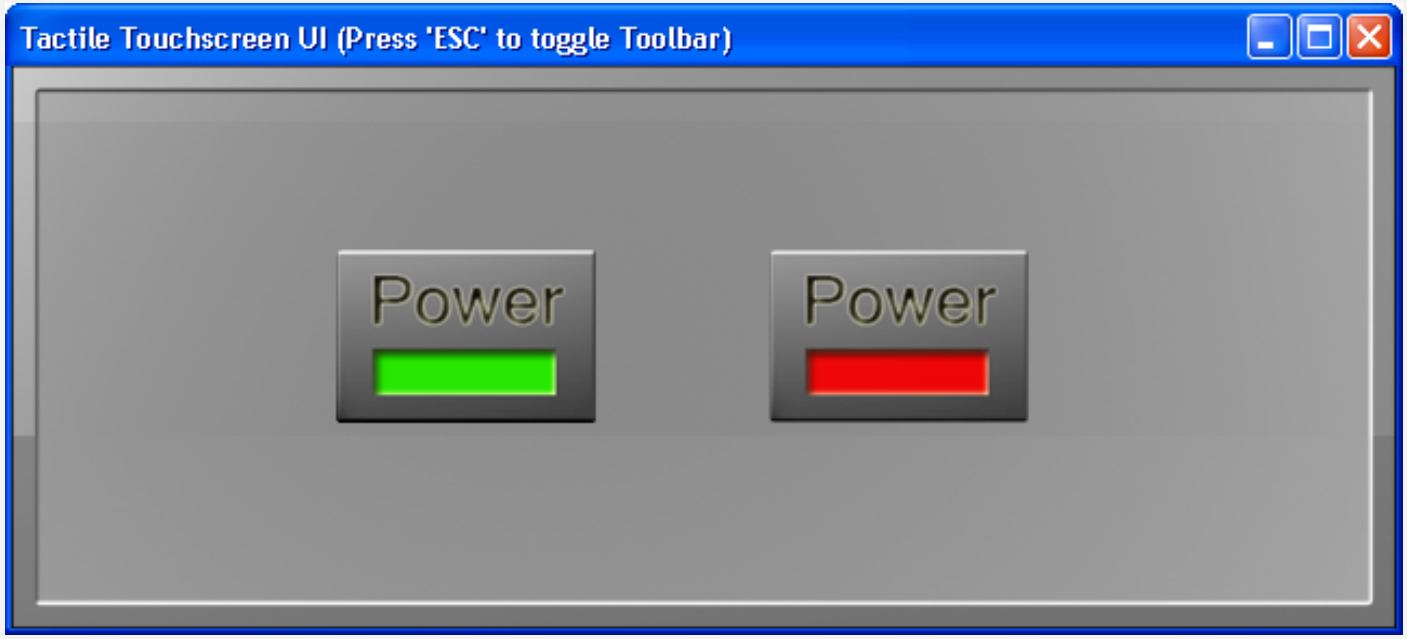


Different trigger setup

Cun Sun
suncu@cip.ifi.lmu.de

Experiment Part Two

- Configurations for Checkbox
Same or different tactile feedback for both states of the checkboxe.



Checkboxes in different states

Cun Sun
suncu@cip.ifi.lmu.de

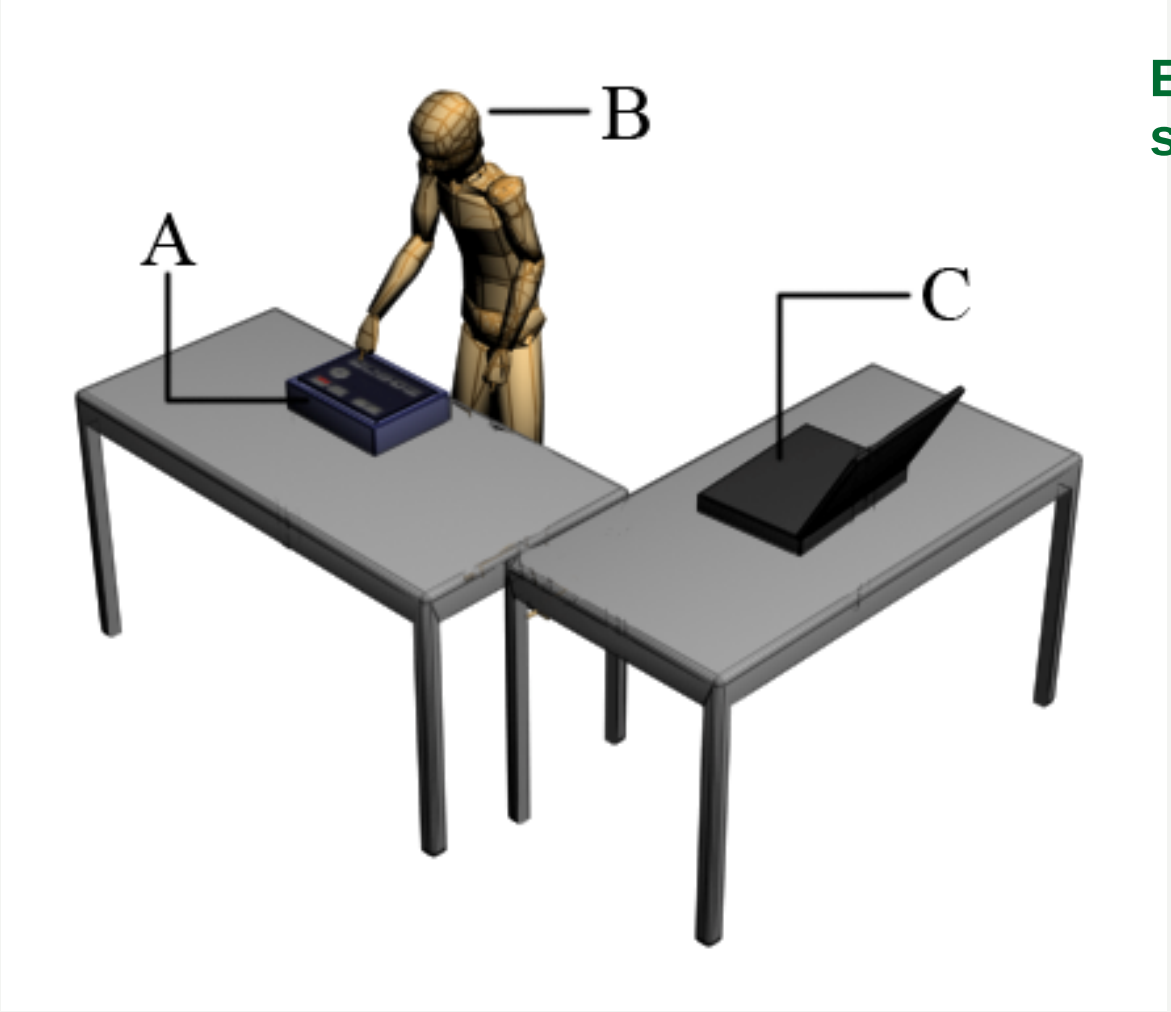
Experiment Part Three

- The imaginary UI: Stereo Player + Lighting Control

The UI for stereo player and lighting control

Cun Sun
suncu@cip.ifi.lmu.de

Experiment Part Three

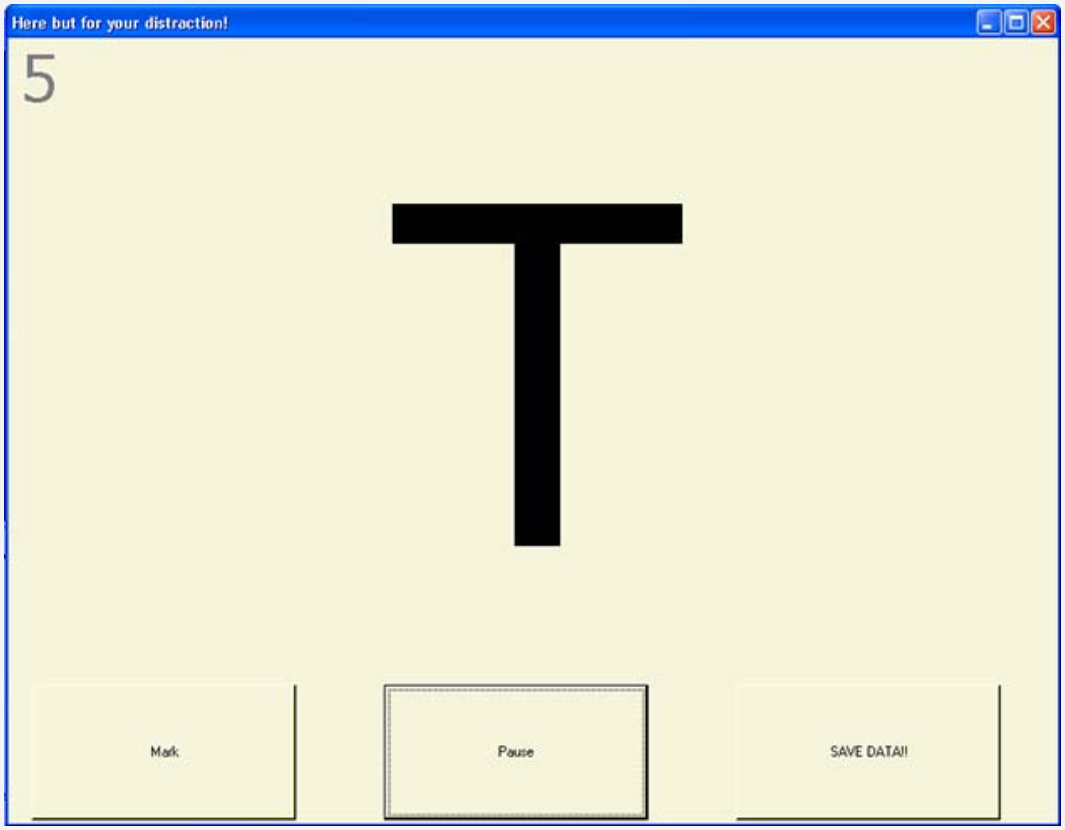


Experiment part three setup

Cun Sun
suncu@cip.ifi.lmu.de

Experiment Part Three

- Primary task
- Secondary task
- Headphone with noise sound
- Execution time and error rate



Secondary task

Tactile Feedback for Touch-sensitive Surfaces

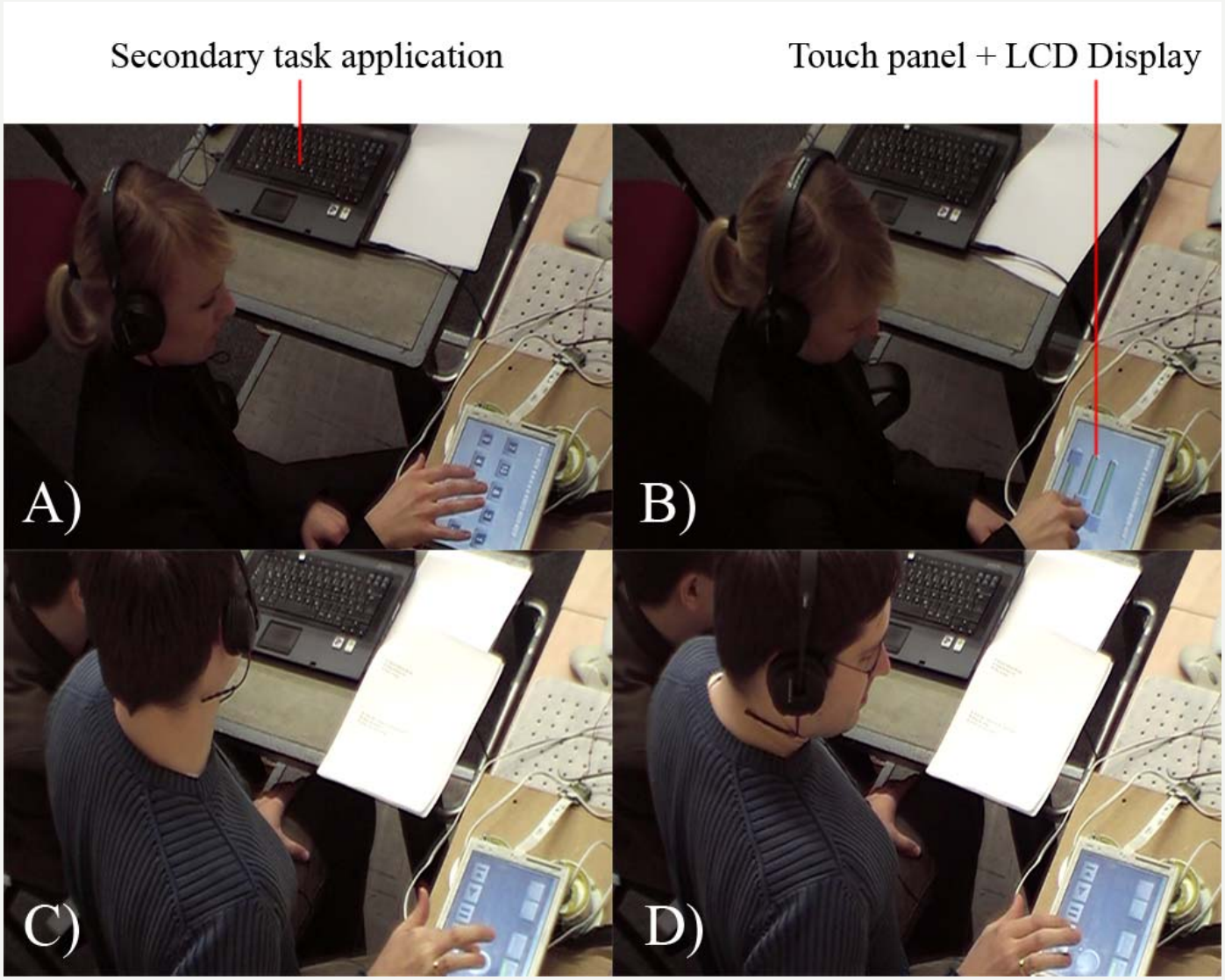
Cun Sun
suncu@cip.ifi.lmu.de

User Study

Participants:

- Eighteen volunteers
- Average age: 33
- All participants have basic computer skills.

- Average duration: 40 minutes.



Participants during experiment part 3

Cun Sun
suncu@cip.ifi.lmu.de

Results

Experiment Part One

Button: Tactile Feedback without short intense pulse at the end significantly better rated

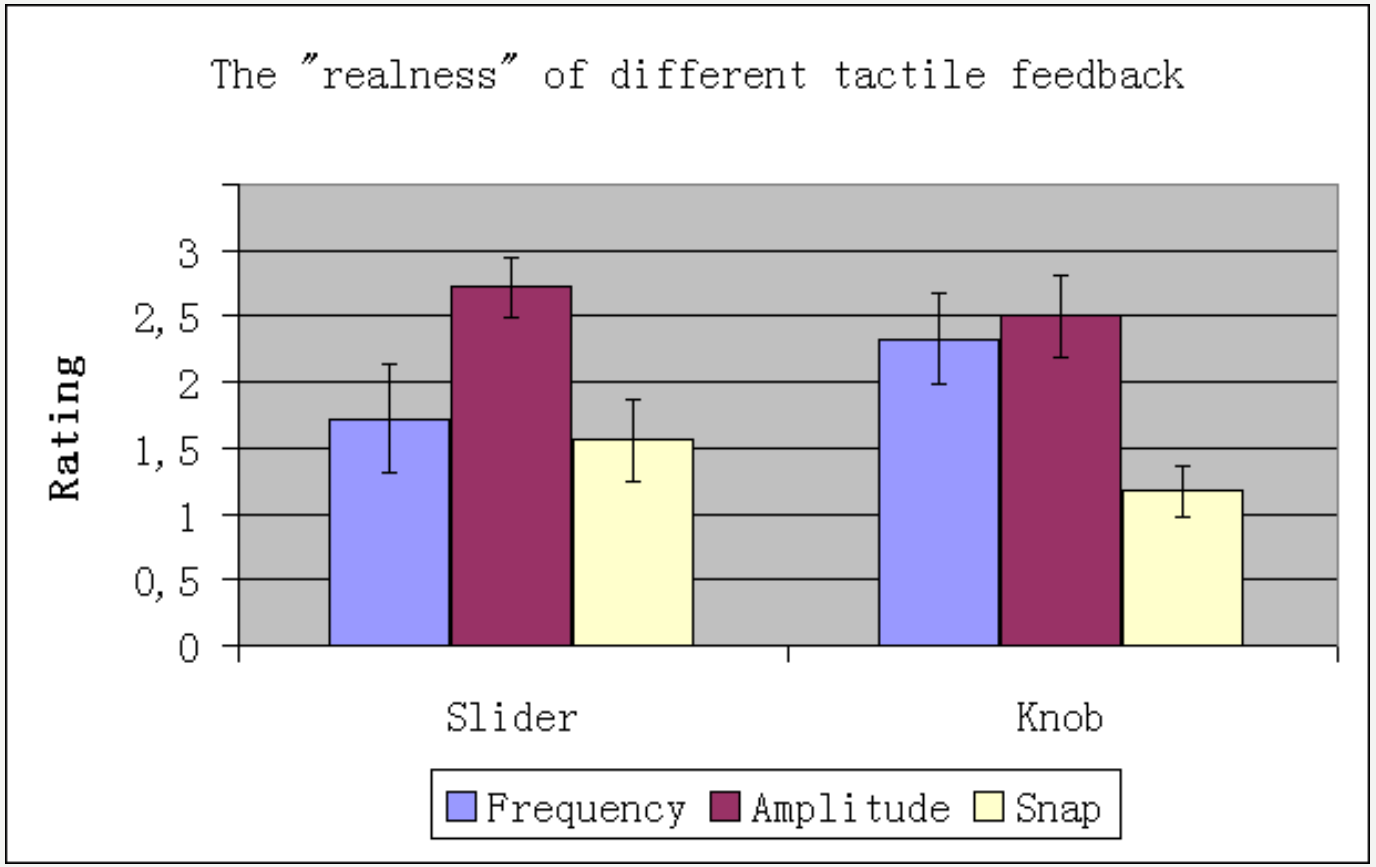
Slider:
Frequency change variation significantly better rated than discrete.

Knob:
Both frequency change and amplitude change significantly better rated than discrete

Cun Sun
suncu@cip.ifi.lmu.de

Results

Experiment Part One



Ratings for slider and knob

Cun Sun
suncu@cip.ifi.lmu.de

Results

Experiment Part Two

- Single button:
No significant difference

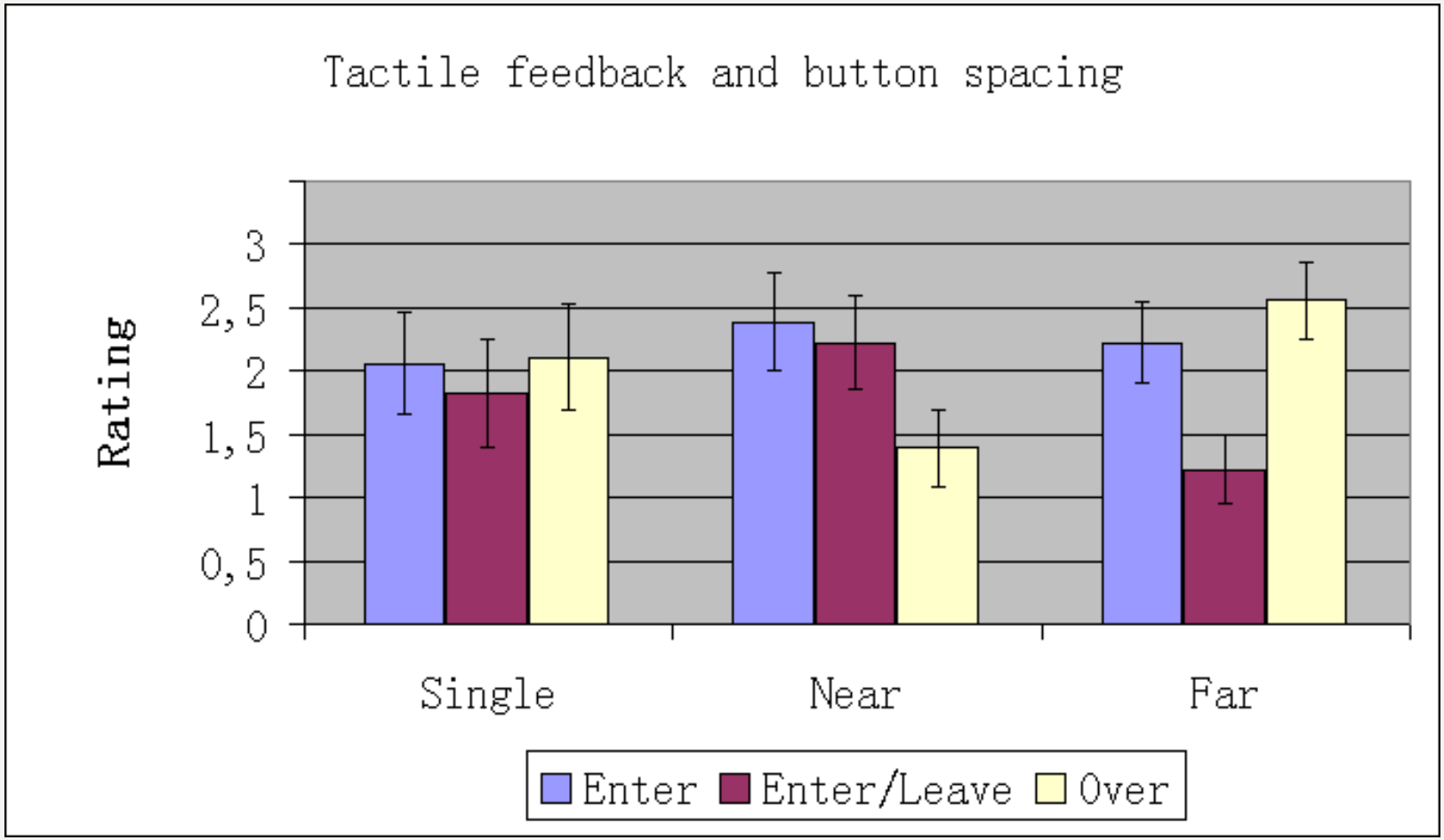
- Buttons near each other:
First variation significantly better rated than the third variation

- Buttons far from each other:
Both the first and third variation significantly better rated than the second variation

Cun Sun
suncu@cip.ifi.lmu.de

Results

Experiment Part Two



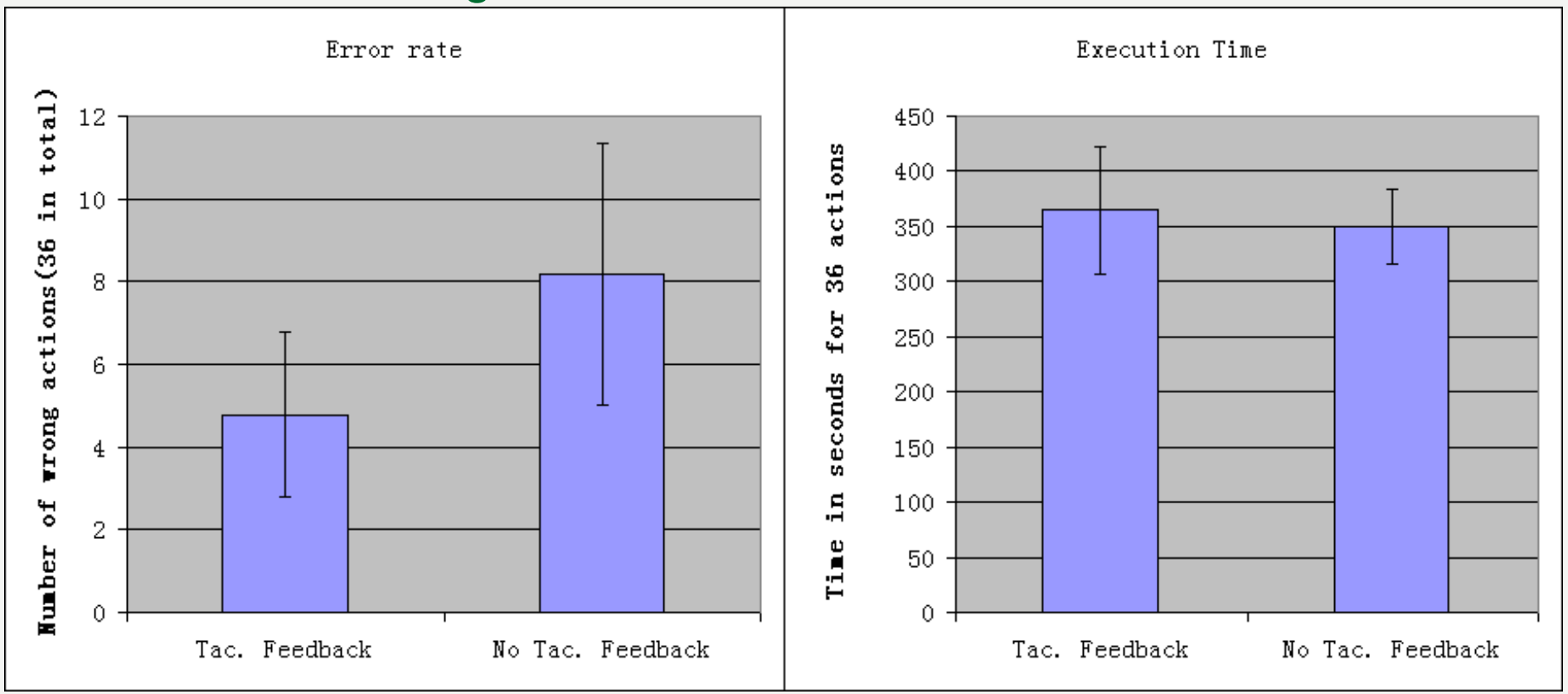
Different trigger configurations for buttons with different spacing

Cun Sun
suncu@cip.ifi.lmu.de

Results

Experiment Part Three

- Error rate lower with tactile feedback, but not significantly
- Execution time no significant difference



Error rate and execution time with and without tactile feedback

Cun Sun
suncu@cip.ifi.lmu.de

Summary:

- No tactile feedback with best “realness”

- Amplitude change better rated for both slider or knob.

- Different trigger techniques for different spacings

- States of checkbox not perceived as useful

- No significant improvement in execution time and accuracy

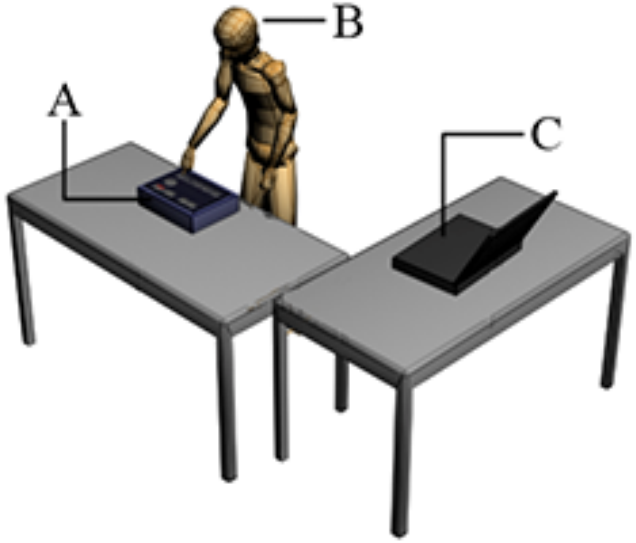
Cun Sun
suncu@cip.ifi.lmu.de

Summary:

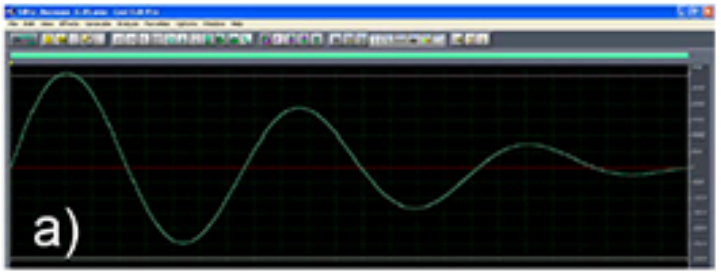
Suggestions for future research:

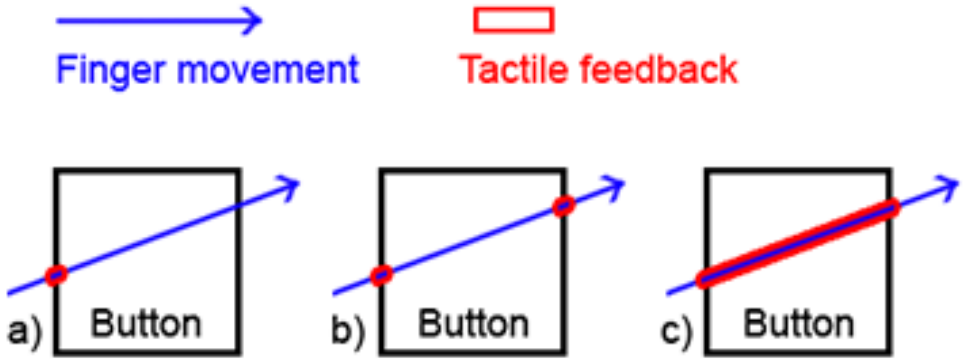
- Other UI elements
- More time for participants to familiarize themselves with tactile feedback

Cun Sun
suncu@cip.ifi.lmu.de



Questions?





Cun Sun
suncu@cip.ifi.lmu.de

Reference:

[1] Brewster, S. A., Brown, L. M., Tactons: Structured tactile messages for non-visual information display, In: Proceedings of the 5th Australasian User Interface Conference, Sydney, Australian Computer Society, 2004, pp.15-23

[2] Brown, L. M., Brewster, S. A., Purchase, H. C., A first investigation into the effectiveness of tactons, In: Proceedings of the First Joint Eurohaptics Conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems, Los Alamitos, CA: IEEE Computer Society, 2005, pp. 167-176

[3] Brown, L. M., Brewster, S. A., Purchase, H.C., Multidimensional Tactons for Non-Visual Information Presentation in Mobile Devices, In: MobileHCI'06, Helsinki, Finland, 2006, pp. 231-238

Cun Sun
suncu@cip.ifi.lmu.de

[4] Fukumoto, M., Sugimura, T., Active Click: Tactile feedback for touch panels, In: Extended Abstracts of CHI '01, ACM Press, NY, 2001, pp. 121-122
[5] Hall, M., Hoggan, E., Brewster, S., T-Bars: Towards Tactile User Interfaces for Mobile Touchscreens, In: MobileHCI 2008, Amsterdam, 2008, pp. 411-414
[6]Hoggan, E., Brewster, S. A. and Johnston, J. Investigating the Effectiveness of Tactile Feedback for Mobile Touchscreens, In: Proceeding of the Twenty-Sixth Annual SIGCHI Conference on Human Factors in Computing Systems April 5-10, 2008, Florence, Italy, 2008, pp. 1573-1582
[7]Poupyrev, I., Maruyama, S., and Rekimoto, J., Ambient touch: Designing tactile interfaces for handheld devices, In: Proc of UIST '02. ACM Press, NY, 2002, pp. 51-60
[8]Nashel, A., Razzaque, S., Tactile Virtual Buttons for Mobile Devices, In: CHI 2003, Ft. Lauderdale, Florida, USA, 2003, pp. 854-855
[9]Leung, R., MacLean, K. , Bertelsen, M., Saubhasik, M., Evaluation of Haptically Augmented Touchscreen GUI Elements Under Cognitive Load, In: ICMI'07, Nagoya, Aichi, Japan, 2007, pp. 374-381