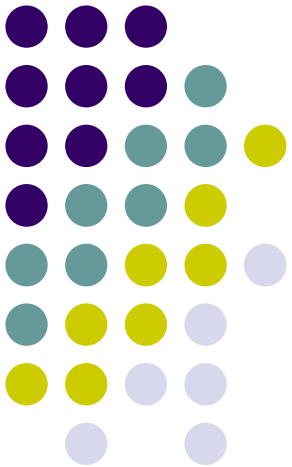
Ubiquitous and Mobile Computing CS 528: Duet: Exploring Joint Interactions on a Smart Phone and a Smart Watch

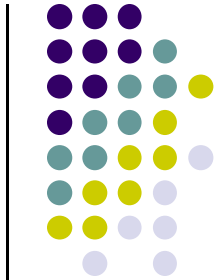
Zhiming Hong

Computer Science Dept.

Worcester Polytechnic Institute (WPI)

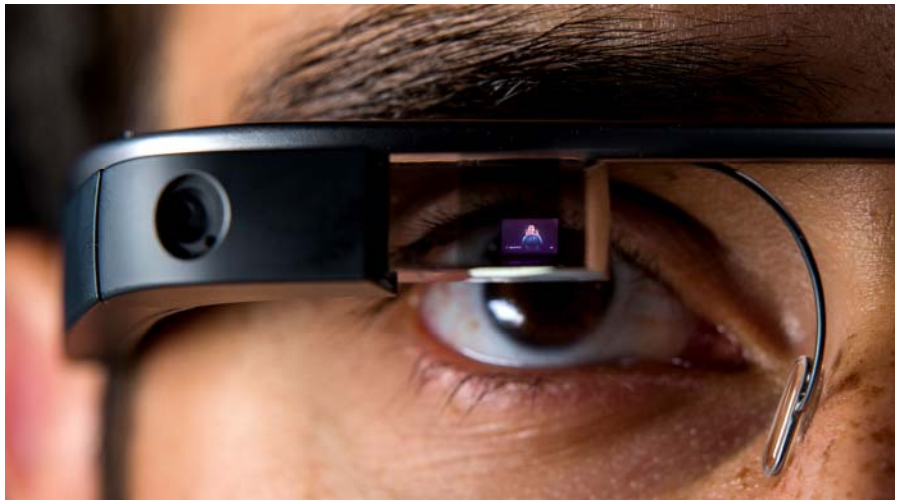


Overview



- Introduction and motivation
- Related work
- Method
  - Design space
  - Gestures and sensing techniques
    - Evaluation(Results)
  - Duet system
    - User feedback(Results)
- Conclusion
- Reference

Introduction



Introduction

Introduction

+

Multi-devices

Introduction

New Interaction way

Availability ↑

https://www.youtube.com/watch?v=oWu9TFJjHaM

Introduction

What this paper focus on?
Why this problem is important?

+

https://www.youtube.com/watch?v=ZKGsb2F9dms

Related work

- **Interaction Techniques for Handheld Devices**
  - **Touch-based interaction**
  - **Orienting,positioning,tilting,and whacking**

Butler, A., Izadi, S., and Hodges, S. SideSight. *UIST '08*, 201–204

Jones, B., Sodhi, R., Forsyth, D., Bailey, B., and Maciocci, G. Around device interaction for multiscale

Fitzmaurice, G.W. Situated information spaces and spatially aware palmtop computers. *CACM 36*, 7 (1993), 39–49

Related work

- **Interaction Techniques for Wrist-worn Devices**
  - **Zoomboard**(iterative zooming)
  - ***Motion and spatial awareness****(*wrist-based*)*
  - ***Free-hand gestures****(magnetometer)*

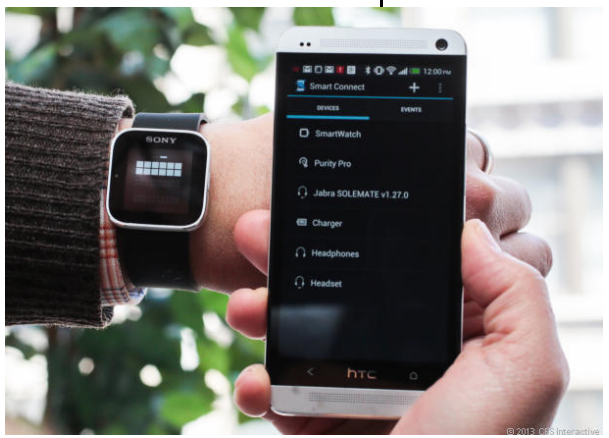
Oney, S., Harrison, C., Ogan, A., and Wiese, J.ZoomBoard. CHI ’13, 2799–2803

Lyons, K., Nguyen, D., Ashbrook, D., and White, S. Face

Rekimoto, J. GestureWrist and GesturePad. ISWC ’01, 21–27

Harrison, C. and Hudson, S.E. Abracadabra. *UIST ’09*, 121–124

Related work



- **Device-to-Device Interaction**
  - ***Synchrony***

    Rekimoto, J. Pick-and-drop. *UIST '97*, 31–39
  - ***Proxemic Interaction***

    Kortuem, G., Kray, C., and Gellersen, H. Sensing and visualizing spatial relations of mobile devices.
    UIST '05, 93
  - ***Distributed Interactions***

    Schilit, B., Adams, N., and Want, R. Context-Aware Computing Applications.*First Workshop on Mobile Computing Systems an Applications*, 85–90

Method

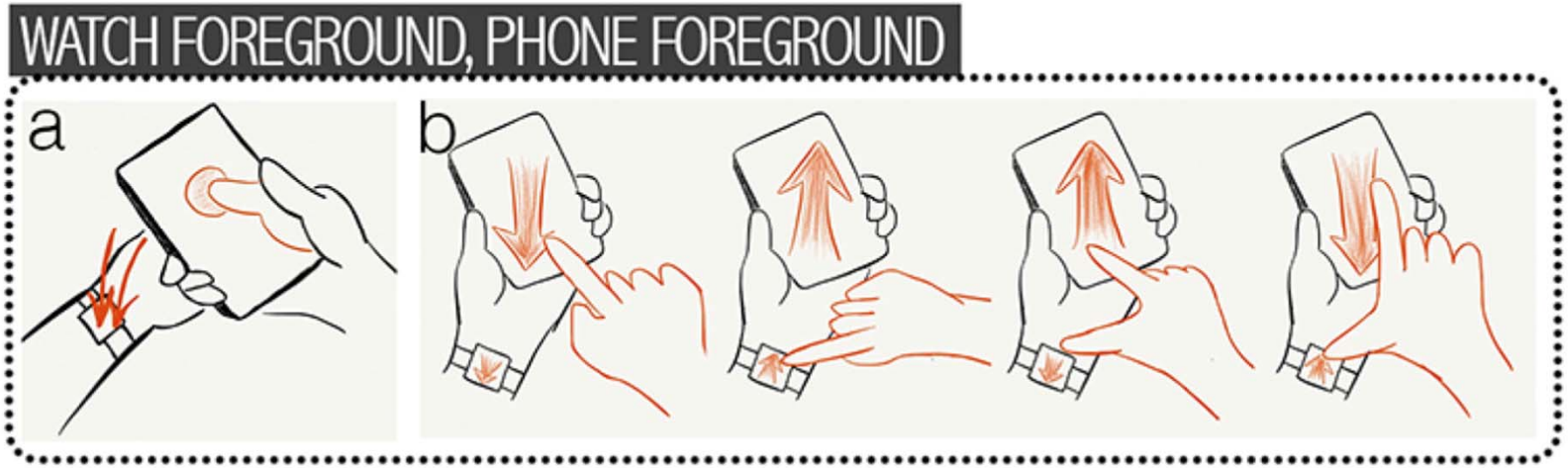
- **Design space**

	Watch Foreground	Watch Background
Phone Foreground	Duet: • Phone as a primary input and output platform; • Watch as an input device or extended display.	Duet: • Phone as a primary input and output platform; • Watch as a sensor.
Phone Background	Current commercial designs: • Phone as an inactivated information portal [37] • Watch as a viewport or remote control [37]	Prior research: • Both phone and watch used for context and activity sensing [7, 31].

Table 1. A design space of interaction on a smart phone and a smart watch based on Buxton's framework [5].

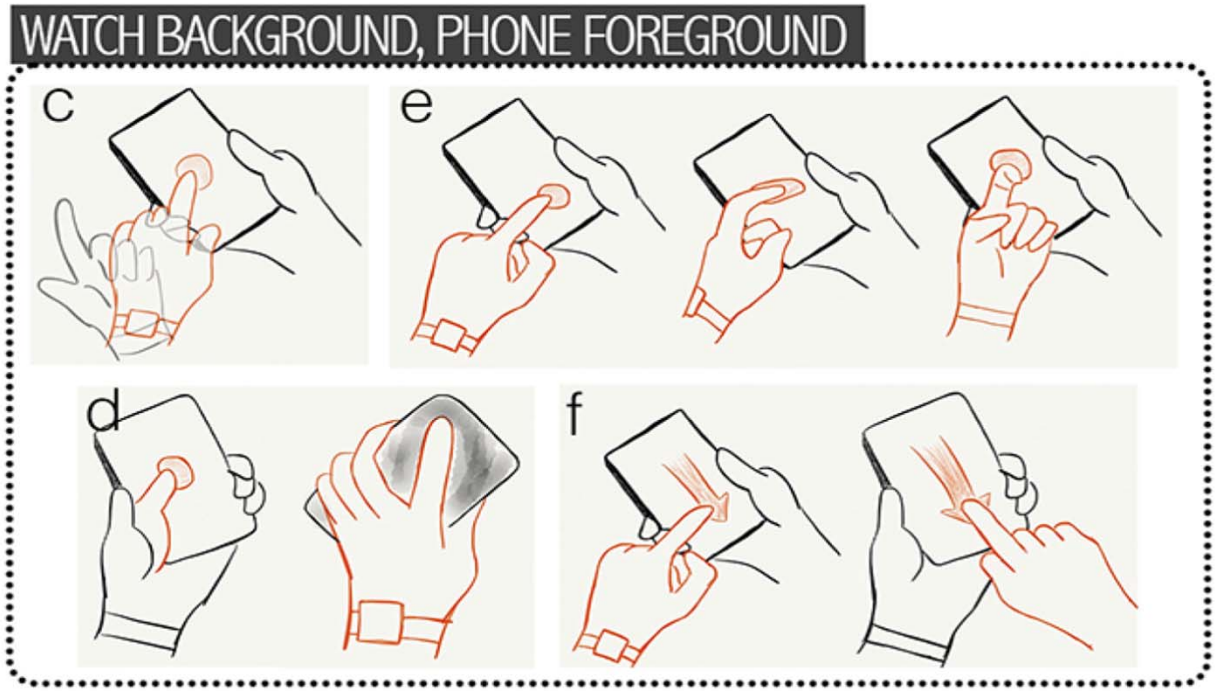
Method

- **GESTURES AND SENSING TECHNIQUES**
  - **Watch in the Foreground, Phone in the Foreground**
    - *Double bump*
    - *Multi-device gestures*



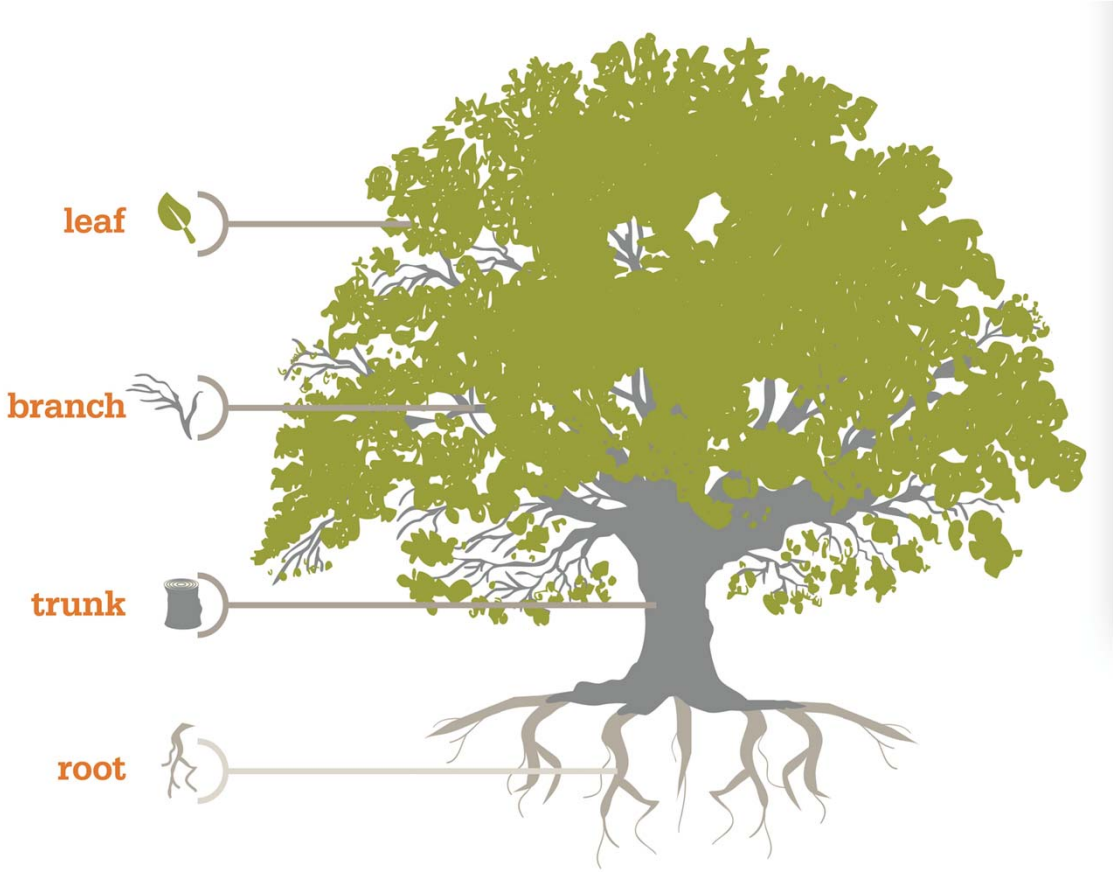
Method

- **GESTURES AND SENSING TECHNIQUES**
  - **Watch in the Background, Phone in the Foreground**
    - *Flip and tap*
    - *Hold and flip*
    - *Finger posture recognition*
    - *Handedness recognition*

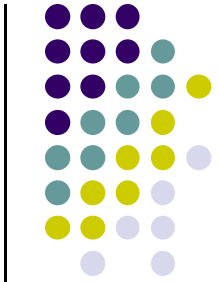


Method

- **Gesture Recognition**
  - **machine learning**
    - Decision Tree



Method



- **TECHNICAL EVALUATION**
  - **Participants**
    - 12 participants(5 male,7 female, ages 18-34)
    - each participant: 10 trials for each condition of these 6 gestures
    - 12 participants × 15 conditions (across the 6 techniques) × 4 blocks × 10 trials per block = 7200 data points
  - **Ten-Fold Cross Validation**
    - Per User Classifiers
    - General Classifiers

Method

- **TECHNICAL EVALUATION**
  - **Results**

	Double bump	Flip and tap	Hold and flip	Handedness recognition	Finger posture recognition
10-fold cross val.	93.87%	97.90%	97.56%	99.06%	99.34%
Per user classifiers	92.10% (5.34%)	95.92% (2.89%)	90.11% (11.24%)	97.33% (1.92%)	97.95% (0.80%)
General classifiers	88.33% (9.89%)	94.38% (9.91%)	85.29% (10.90%)	98.23% (2.64%)	93.33% (9.07%)

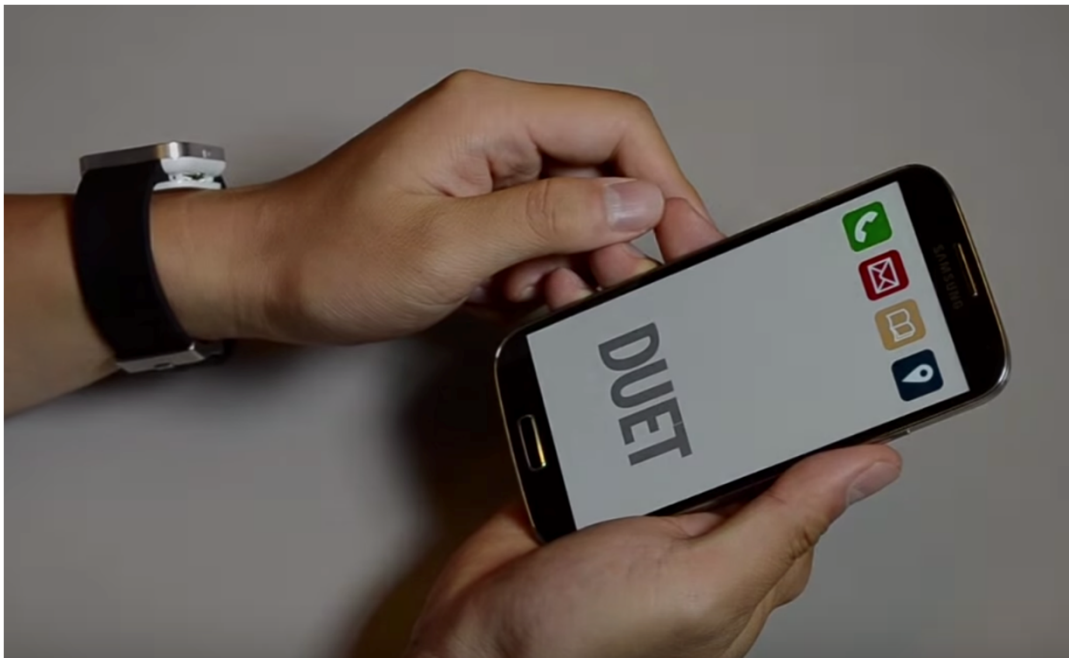
Table 2. Accuracy (SD in parentheses) of our gestures and sensing techniques: ten-fold cross validation, per user classifiers, and general classifiers.

Pinch to open	Pinch to close	Phone to watch	Watch to phone
97.69% (5.67%)	98.61% (2.32%)	95.83% (3.83%)	96.76% (3.25%)

Table 3. Accuracy (SD in parentheses) for *Multi-device gestures*.

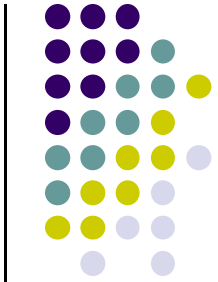
Method

- **DUET: AN EXPLORATION OF JOINT INTERACTIONS**
  - **Home Screen**
  - **4 mobile apps**
    - Email
    - Map
    - Reader
    - Call



https://www.youtube.com/watch?v=i3XcCuWuec4

Method



- **User feedback on** DUET
  - Participants
    - 10 participants(5 male, 5 female, ages 21-27)
  - Procedure
    - 60 minutes try out DUET by themselves
    - comment on their easiness and usefulness

Method

- Results

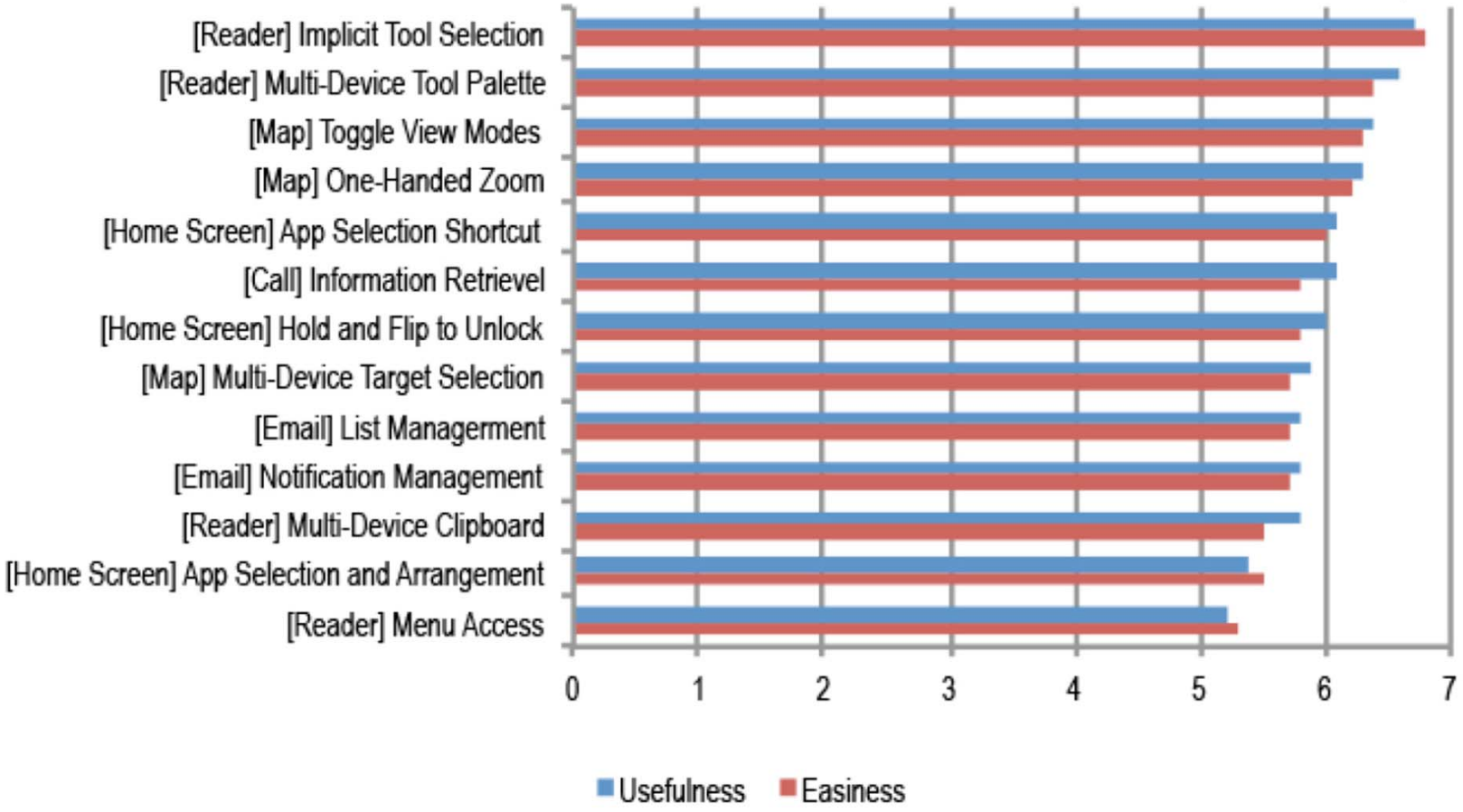
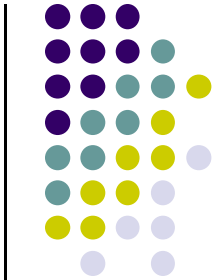


Figure 13. Subjective rankings show an overall positive reaction to Duet's interaction techniques.

Conclusion



- New interaction ways between smart phone and smart watch
- “Duet” system: exploring those new joint interactions

Improvements:

- Number and variety of participants for test
- *Recognition robustness*
- *Watch wearing*

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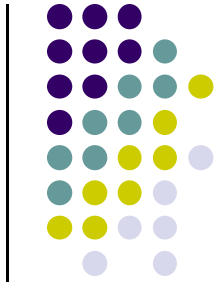
  UIST ’05. 93.



Thank you!

Question??