Computing Science GLASGOW

HCI4 06

GIST
GLASGOW INTERACTIVE SYSTEMS GROUP

Mobility and Interaction

Phil Gray

overview

- We will look at aspects of
  - Information presentation
  - Input Techniques
- Matthew will talk about location and wireless comms aspects of mobility separately

What's the domain?

- Mobile devices
  - can mean
    - Transportable
    - Usable while moving
      - On foot, as driver, as passenger
  - Weiss' definition of handheld: it must
    - Operate without cables, except temporarily
    - Be easily used in one's hands
    - Allow addition of applications or support internet connectivity
- Mobility of user doesn't imply mobile devices
- But, this lecture is primarily about mobile devices

What are the HCI challenges?

- Volatility
  - World is moving quickly
  - Still a plethora of different OS, IO devices, peripherals, physical form factors
  - Also means I (and these lectures) can't be entirely up to date or comprehensive
- Size
  - Small is tricky but, so far, necessary
  - Challenges for input and output
- Use in "demanding" environments
  - On the move
  - dynamic contexts
  - Uncontrolled/serendipitous situations
- Novelty
  - Input & output techniques are still being developed
    - Little investigation, poor understanding
  - No single standard, unlike world of desktops

Focus of this lecture

- Will look at a representative selection of HCI-oriented concerns
  - Presenting web information on small displays
  - Comparing text to speech while on the move
  - Improving target acquisition on small displays with sound
  - Comparative performance of text input techniques

Presenting web information on small displays

- From ***MacKay et al. Web Page Transformation When Switching Devices. Proc Mobile HCI 04. pp. 228-239.***
- Three strategies for web page display
  - Direct migration
    - No change to page; Hence no information loss
    - Requires 2D panning/scrolling
  - Linear transformation
    - Restructure to remove horizontal scrolling
    - Page is long linear structure; May include segmentation; Information may be lost
  - Overview transformation
    - Give overview of original plus access to information segments

BBC Website in 3 Versions

Fig. 2. Three Small Screen Transformations

Usability Issues

- Short line length slows reading
- Targets, like buttons, hard to hit
- Structural transformations can disrupt usability of known information structures
  - We know that changes in web structures disorient users and increase info access time
- Best layout may depend on the task
  - Re-finding, finding new info, comparing info, reading info, browsing
  - Differences exacerbated by mobile setting (see "Mobility")
- Mobility
  - Harder to interact because of movement
  - Noise, poor light
  - Interruptions

Mackay et al study

- Compared 3 techniques
- Two tasks
  - Carried out info search on PC and 3 PDA techniques, while stationary
  - Info search while moving with linear and gateway
- Measured user preference and subjective task performance measure

Mackay et al summary

- Comparison
  - Gateway scored best in both ratings
  - However, direct was rated
    - almost equal to gateway for subjective preference
    - Linear and direct rated similarly for task performance
- In mobile study
  - Participants found gateway preferable because they were less likely to get lost
  - Perhaps higher cognitive load increases advantage of familiar layout in gateway

Overall Preferences

Category	Gateway	Linear	Direct
Fastest	15	29	16
Easiest to find story	17	28	15
Most intuitive	16	29	15
Liked using	13	30	17
Total	**61**	**116**	**63**

Task Ratings

Category	Gateway	Linear	Direct
Reading	11	12	30
Finding new story	18	19	23
Re-reading	14	29	17
Comparing details	14	21	25
General browsing	16	22	22
Total	**73**	**103**	**117**

Comparing text to speech while on the move

- ***Vadas et a. Reading On-the-Go: A Comparison of Audio and Hand-held Displays. In MobileHCI'06. pp. 219-226***
- Question: how does reading text on a small display compare to receiving the same information by speech when walking?
- Motivated by disappointing results of visual display in previous study
  - » Compared head-mounted dipslay against 2 handhelds
  - » Head-mounted display was worst .. And all were poor

The Study

- Conditions: Speech versus visual text; sitting vs walking
- Measures: "reading" time, response accuracy, path accuracy, walking speed, workload (TLX)
- 26 partiticipants (20 used), within subjects design, counterbalanced
- Task: read short passages and answer 2 questions on each
  - » While sitting
  - » While walking

Results

- Listening longer than reading (53s vs 39s)
- Answers more accurate when sitting than moving (81% vs 66%)
- Workload:
  - » walking higher than sitting (54 vs 35)
  - » reading higher when walking than sitting (31 vs 59)
  - » Also audio higher when walking (40 vs 49)
  - » Overall, listening has lower workload than reading

Results

- Walking speed & accuracy

	Audio	Visual	Natural
Speed (m/s)	1.03	0.91	1.20
Off-steps / m	0.02	0.09	0.03

  - » Gait less regular in visual condition
- Overall, audio rated less demanding than reading when walking

Improving target acquisition on small displays with sound

- ***Steve Brewster. Overcoming the Lack of Screen Space on Mobile Computers. Personal and Ubiquitous Computing 6,3 (2002). Pp. 188-205***
- Problem: selecting small targets is difficult
  - » For seated users, need 26mm^2 for 99% accuracy; 30mm^2 for standing users
  - » "standard" Palm III PDA buttons of 16x16 pixels are 5mm^2
- Hypothesis: adding auditory feedback will improve performance

Experiments

- 2 experiments
  - » Study 1
    - – Stationary Selection tasks with 2 conditions: button size (16x16 and 8x8) and auditory feedback (on or off)
    - – Entering numeric codes in fixed time
    - – 16 participants
  - » Study 2: same as study 1 but performed outside while on the move

Results (codes typed)

	16 w sound	16 w/o sound	Small w sound	Small w/o sound
Indoor	58	45	42	30
Outdoor	42	32	28	18

Differences between Indoor/Outdoor and button size and Sound/No Sound are significant

Gestural Interaction

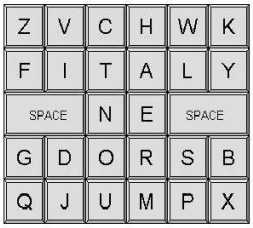
- alternative solutions to selection/navigation problem(s)
  - » Replace target acquisition with gestures
    - – E.g., trace large shapes on display surface rather than hitting target
    - – Early experimental results are encouraging
    - – Another subject of research of Professor Brewster's group
  - » Use continuous rather than discrete interaction with control feedback to reduce mobility issues
    - – Subject of research by Dr Murray-Smith's group

Comparative performance of text input techniques

- Keypad input on phones
  - » Multi Tap
    - – Multiple presses of key will generate different characters
  - » T9
    - – Predictive text entry
    - – Based on dictionary and frequency of selection data
- Stylus based input
  - » Digital ink
  - » Graffiti
  - » CIC's Jot
- Soft keyboards
- Physical keyboards

The Fitaly Keyboard

- Designed for
  - » single finger use
  - » minimum finger travel
- www.fitaly.com



Predictive Text Entry

- ***James & Reischel, Text Input for Mobile Devices: Comparing Model Prediction to Actual Performance, CHI 2001, pp. 365-371.***
- Based on comparison of multi-tap with predictive text entry (T9)
- Starting point of this work was an inconsistency in the results of two model-based predictions of text entry speed
  - » GOMS model
  - » Fitt's Law model
- Question: which predictions are most accurate?

Predictive Text Entry

- Carried out experiment comparing multitap vs T9 for experts and novices entering chat and newspaper text
- Nokia 3210
- 20 participants; equal nos of novice and expert users

Predictive Text Entry

Mean WPM

Method	Novice	Expert
Multitap	7.98	7.93
T9	9.09	20.36

Total Errors

Method	Novice	Expert
Multitap	65	116
T9	44	34

Other Observations

- Models deficient in several respects
  - didn't handle the cognitive cost of mental preparation
  - doesn't include verification time
    - Anecdotally higher for multitap than T9
- Other issues
  - Type of text affected error rate more greatly for one technique than another
  - Hence, have to be careful in text choice to avoid bias
- And you don't need 9 keys…

Variants of non-predictive entry

- ***Butts & Cockburn. An Evaluation of mobile phone text input methods. Proc OzCHI 2001. pp. 55-59.***
- Compared multi-press with timeout, multi-press with next & two-key method
- Multi-press with next fastest (7.2 wpm) followed by MP with timeout (6.4) and two key 5.5
- No difference in learnability or error-rate
- Subjects found task frustrating
  - Bad interaction with prior habits
- Similar results to other empirical studies, but much worse that reported theoretical model using Fitt's Law

Graffiti vs Soft Keyboard

Mean WPM

Method	Novice	Expert
Graffiti	7	21
Keyboard	15	18

- From ***Fleetwood et al. An Evaluation of Text Entry in Palm OS – Graffiti and the Virtual Keyboard.Proc Human Factors and Ergonomics Society, 2002.***
- Graffiti error rate remains persistently higher (9%) than keyboard (2%)
- Note that expert Graffiti use is close to manual printing speed (26 wpm) so little room for improvement of the basic technique

Some final observations

- A good source of additional research:
  - MobileHCI conferences. Check the ACM DL portal.
  - Scott Weiss. Handheld Usability. Wiley, 2002.
    - Dating fast
    - Not very deep
  - Matt Jones & Marsden. Mobile Interaction Design. Wiley 2006.
- Technology, applications and interaction techniques are still developing fast enough that it is difficult to generate useful general guidelines