EXHIBIT E

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AppLens and LaunchTile: Two Designs for One-Handed Thumb Use on Small Devices



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Why One-Handed Interaction?

One hand occupied





Unstable environment

Attention divided among tasks





Two handed use unnatural



Input and Interaction on Existing Devices

Smartphones

- Input: Hardware Buttons
- Interaction: One-handed
 Keypad-mapped functions
 Directional navigation



Personal Digital Assistants (PDAs)

- Input: Touch Sensitive Display Hardware Buttons
- Interaction: Two-handed
 Small software targets
 Directional navigation



Design Goal

- Scalable User Interface (ScUI)
 - Single design & interaction architecture
 - Multiple resolutions & aspect ratios
 - University of Maryland's PocketPiccolo.NET toolkit for Zoomable User Interfaces (ZUIs)



iMate Smartphone II



HP iPAQ PocketPC



One Application, Two Designs

AppLens: Fisheye+Pan

- 9 Application Tiles
- Fisheye Zoom
- Command-Based Gestures





LaunchTile: Zoom+Pan

- 36 Application Tiles
- Pure Zoom
- Direct Manipulation Gestures



Related Work

- Gestures using Position & Orientation
 - General Purpose [Reikimoto 1996] [Hinkley 2000]
 - Text Entry [Sazawal 2002] [Widgdor 2003]
- Gestures with Stylus
 - App Specific
 - Text Entry

- [Buyukkokten 2000] [Baudisch 2004]
- [Perlin 1998] [Wobbrock 2003]
- Thumb-Based Hardware



Jackito PDA

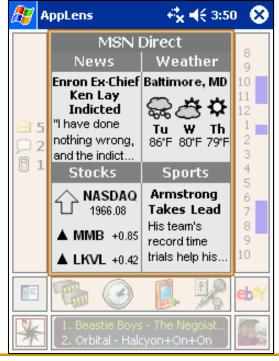


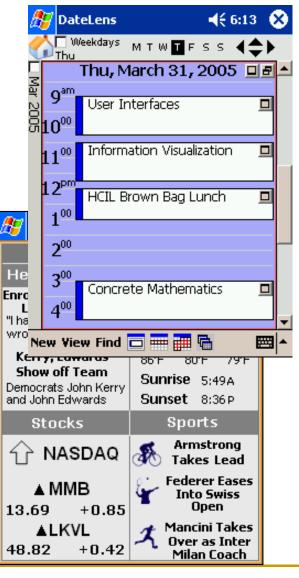


AppLens Visual Design

- Generalized tabular fisheye
 Motivated by DateLens calendar
- Three (fisheye) zoom levels







HCI

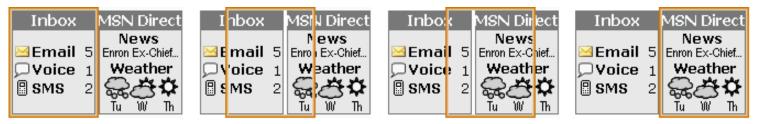


Context

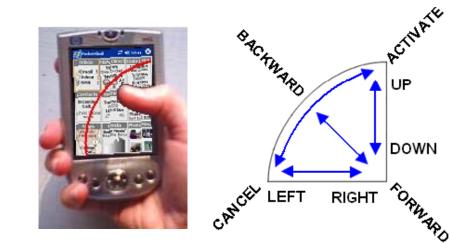
Full



AppLens Interaction DesignInput cursor



- Command gestures
 - Issued anywhere
 - Access distant widgets
 - Don't interfere with tap





Interactive prototype based on images

669 First B

Seattle E

5 Intern

M**ap**Point

July 31

LaunchTile Visual Design

Three (pure) zoom levels



Tech News TINTC TINTC BIA2 BIA2 BIA2 Complete at Bada

World

"Blue"

Zone

WiFit

🖻 Ben Bederson 🐸 Bongwon Suh 🙈 Chris Stone 🖂 Larry Davis 🙈 John SanGiovanni 🖻 Jacqueline Wahl 🐸 Delivery Notifica Inbox 8:50AM Phone 🐴 💋 Missed Call 🍯 Bill Tomkins (w) 🔰 Outgoing Call Anne Iasella (m) Voicemail 👂 Mom & Dad (տ)

= 11 Unread —

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HCI

Application

Navigation Landmarks

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EIncoming SMS

Kelly Goto (m)

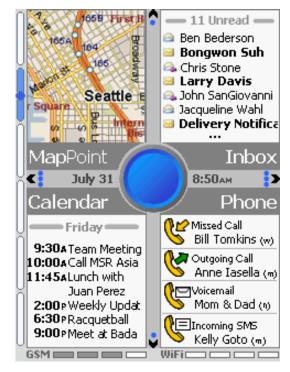
LaunchTile Visual Design

Three (pure) zoom levels



World

"Blue"



Zone



Voice

HCI

Back

Application

Navigation Landmarks

LaunchTile Visual Design

Three (pure) zoom levels





HCI

Application

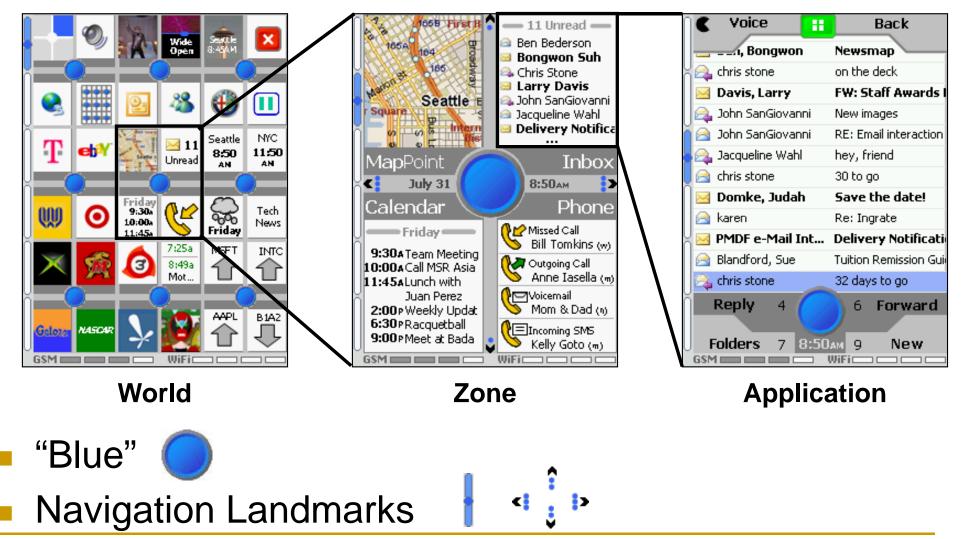
Navigation Landmarks

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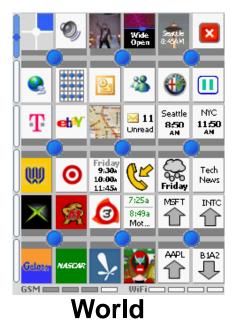
LaunchTile Visual Design

HCIL

Three (pure) zoom levels



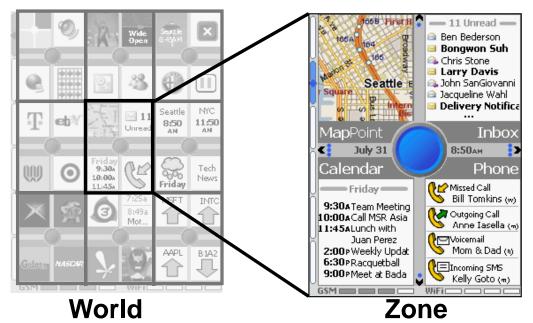




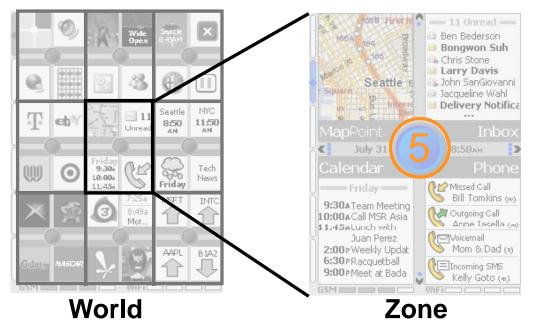




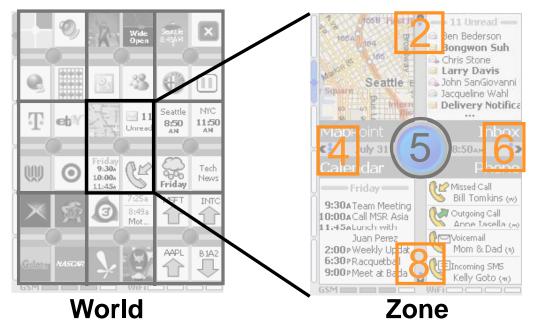




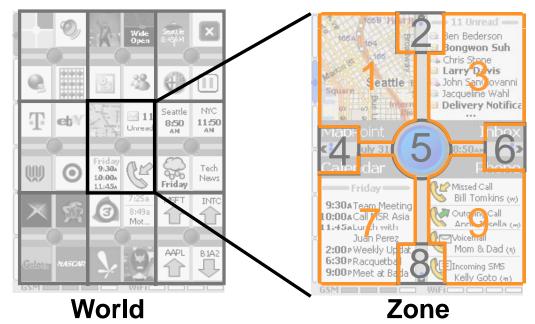






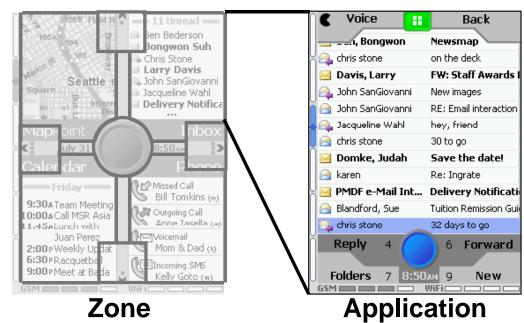






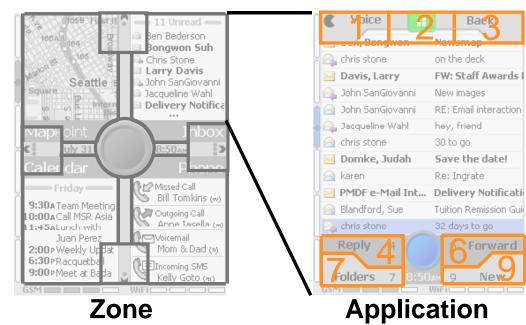






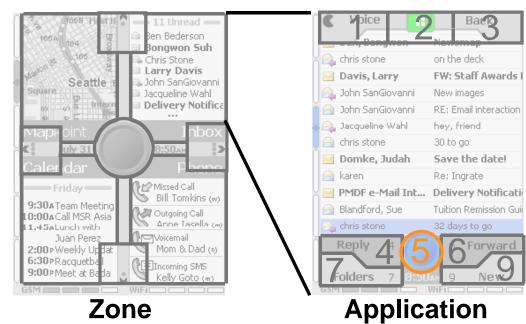






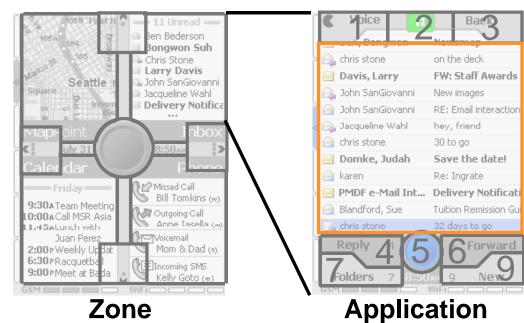


















- **Direct Manipulation Drag Gestures**
 - Zoomspace
 - Application content
 - Toolglass

LaunchTile Video

Interactive prototype based on images

Reference study

Back

FW: Staff Awards

RE: Email interaction

Save the date!

Delivery Notificati

Tuition Remission Gui

6 Forward

New

Newsmap

on the deck

New images

hey, friend

Re: Ingrate

32 days to go

30 to go



AppLens Command Gesture Study

Gestures learnable with minimal training?

Participants

- 20 (12 Male, 8 Female)
- 12 advanced computer users
- G regular PDA users

Time

- Training: 5-15 minutes
- Tasks: 15-30 minutes



Methods

- Tasks
 - Gesture
 - Navigation

- Measures
 - Correctness and Speed
 - Correctness and Efficiency

Environment

- Hierarchical
- Tabular
- Zoomable

87 Navigation Phase 📰 ◀€ 10:33 🔇 Navigate to 6.5.4			Navigation Phase # ◀€ 10:34 🔇 Navigate to 6.5.4			87 Navigation Phase 📰 ◀€ 10:36 🔇 Activate the 5 in 6.5.4		
1	2	3	6.5.1	6.5.2	6.5.3	6.5.1	6.5.2	6.5.3
4	5	6	6.5.4	6.5.5	6.5.6	6. 5 .4	6.5.5	6.5.6
7	8	9	6.5.7	6.5.8	6.5.9	6.5.7	6.5.8	6.5.9



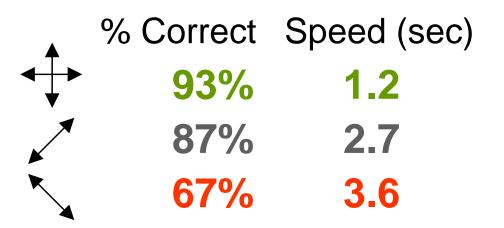
Gesture Study



HC

Results

- Gesture Tasks
 - Directional
 - Activate / Cancel
 - Backward / Forward
- Navigation Tasks
 - 95% correct
 - +2.4 gestures per task
 - Most of the problems from one third of users
- Subjective Reactions on 9-Point Scale
 All between 5.9 6.75 (9 was best)



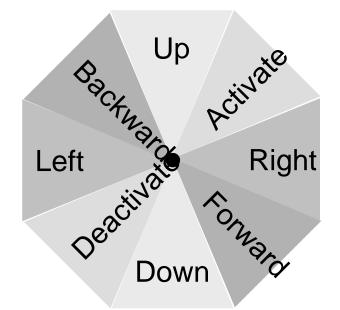


Discussion

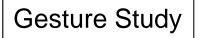


Errors from recall or <u>execution</u>?

Logs indicate both



- Navigation better than Action Gestures
 - Spatial mapping helps learnability
 - Abstract mappings require more effort
 - Similar mappings can be confusing



Formative Study Comparing Designs

Goals:

- Usability issues
- Comparative preferences
- Participants:
 - 10 (8 Male, 2 Female)
 - All advanced computer users
 - 4 regular PDA users

Time:

45 minutes: 15 per interface, 15 discussion

Comparative Study

Method

Software:

Tasks:

Exercised navigation & interaction features

Measures:

- Subjective reactions
- Comparative preferences







Results: AppLens

Likes

- Easy to learn
- Effective to navigate
- Comfortable
- Fisheye valuable
- Simultaneous access to apps
- Usability Issues
 - Gestures were hardest part

AppLens	🛻 🖣 🗧 12:44 🛛 🗙				
Inbox Email 5 Voice 1 SMS 2	MSN Direct News Enron Ex-Chief Weather Weather Tu W Th	Date Lens 10:00AM Meet w Ben 1:15pM Dentist 6:45pM Climb w Chris			
Contacts Incoming Call Chris Stone WORK	Settings Tuesday 6/29 10:47AM # • • • • • • • • • • • • • • • • • • •	Explorer etc://ebay.com 2 Prs. Tent last bid:\$25 Thule Rack last bid:\$20			
Maps University of Maryland 1 College Park	Media Body Movin' Beastie Boys	PhotoMesa			



Comparative Study

Results: LaunchTile

Likes

- Effective to navigate
- Comfortable
- □ "Blue"
- Access to many apps
- Dislikes
 - Too many apps
- Usability Issues Multi-modal "Blue"

Panning in Zone view **Comparative Study**

GSM 📖 📖 📖



Kelly Goto (m)

WiFi

Disorienting



Results: AppLens vs. LaunchTile

- With minimal training, AppLens preferred
 - Easier to use
 - Faster application access
 - Better at-a-glance value
 - For own PDA use



Discussion

- AppLens beats LaunchTile?
 - Not necessarily
 - AppLens was simpler, shallower, fewer apps
 - Easier to learn and manage under time constraints
 - Performance unaffected by device limitations
- General Observations
 - Tapping used more than gestures
 - Utility of notification tiles





Conclusion

Promising Interfaces:

- > One-handed
- Notification-based
- > Tappable
- Unknown:
 - Scalable interfaces
- Potential Challenge:
 - Gesture-based interfaces

