

Human Computer Interaction

L&G AirPanes: Two-Handed Around-Device Interaction for Pane Switching on Smartphones File

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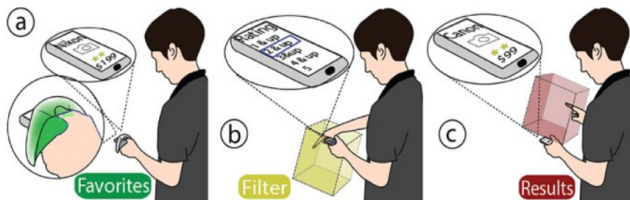
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Overview

- The authors propose **AirPanes**, a novel technique that allows two-handed in-air interactions.
- AirPanes resolves the inefficiencies of having to **switch between multiple views or panes** in common smartphone applications.



The main contributions claimed:

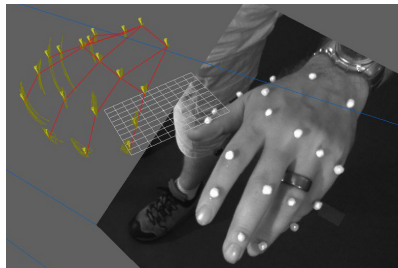
- Exploration of **design factors** that make AirPanes efficient.
- A controlled study finding that AirPanes is on average **50% more efficient than standard touch input** for an analytic task.
- Implementation, experimentation, and **methodical testing** of several alternative in-air interface organizations.
- Recommendations for implementing AirPanes in a broad range of applications.

Related Work

- Prior work shows that the in-air space surrounding a mobile device can be used as an alternative to touch input.
- **HoverFlow**: <https://www.youtube.com/watch?v=b6Fv45Mz7T8>
- **PalmSpace**: <https://www.youtube.com/watch?v=Xl1heTgcBUY>
- **AirPanes**: in-air thumb interaction has received very little attention, and AirPanes investigates the use of this in-air space for a smartphone application. They consider using two different in-air spaces:
 - one controlled by the thumb holding the device
 - the second controlled via the index finger on the hand not holding the device.
- **AirPanes** leverages asymmetric bimanual interaction: the non-dominant hand holding the device creates a reference point which the dominant hand navigates around; the dominant hand performs fine-grained operations such as exploring items and panes, whereas the non-dominant hand (thumb) issues course-grained operations, such as making selections.

Sensor setup

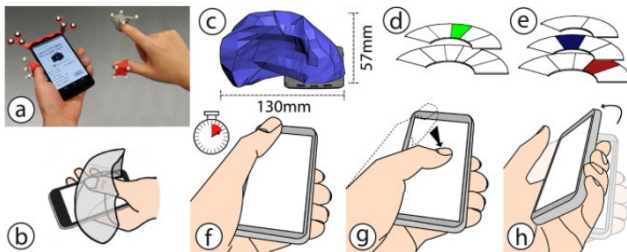
- Vicon **marker-based** tracking system.
- Tracks the position of **non-dominant** thumb.
- And the position of the free, **non-dominant** hand (and fingers).



Selecting in-air regions

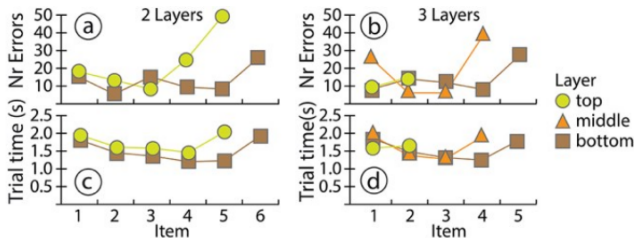
First study: selecting regions

- The authors performed a first set experiment to determine the efficiency and potential of selecting regions.
- Two arrangements of selection targets.
- **Task:** select the blue-highlighted selection region.
- **Selection:** Dwell, Tilt, Touch.



First study: in-air interface error analysis

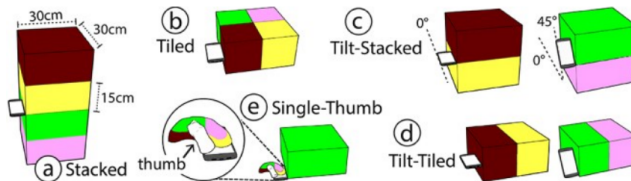
- Test performed by 12 users.
- Selection **time** was measured, and **number of erroneous selections**.
- **Conclusion**: both spatial layouts and all three selection methods are **basically equivalent**; however, **outermost** selection items are **hard to reach**.



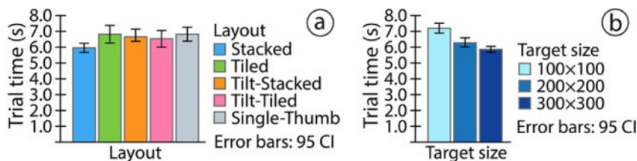
Switching panes

Second study: AirPane layouts

- A second study was performed to determine the best ways to **layout** panes of functionality.
- **Idea**: offload panes to **around-device space**.
- **NOTE**: pane selection made with **in-air** input finger.
- **Five layouts**: Stacked, Tiled, Tilt-Stacked, Tilt-Tiled, Single-Thumb.

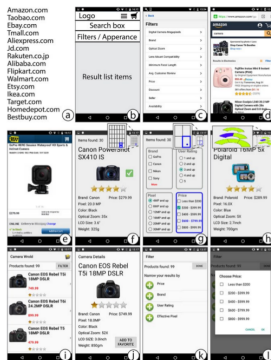


- Test performed by 15 users.
- **Task:** select a **first** target (in one of the four panes), then a **second** target.
- Selection performed by **pinch** gesture with in-air hand.
- **Conclusion:** Stacked Layout fastest (doesn't need secondary gesture), pane switching + selection **pretty fast**.

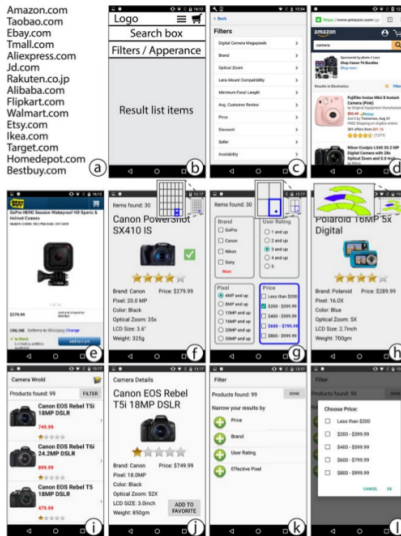


Using AirPanes in an M-Commerce Interface

- The main goal of the work is to implement and integrate AirPanes into an **actual** application.
- The authors surveyed a range of **m-commerce** applications.
- They discovered a number of **commonalities** across these applications.



Amazon.com
Taobao.com
Ebay.com
Tmall.com
Aliexpress.com
Jd.com
Rakuten.co.jp
Alibaba.com
Flipkart.com
Walmart.com
Etsy.com
Ikea.com
Target.com
Homedepot.com
Bestbuy.com



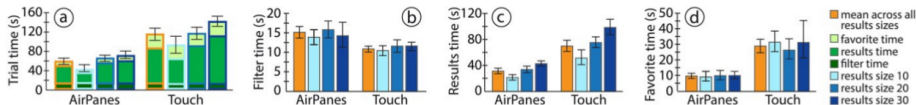
- A text field is used for product search.
- Filter functionality is accessed through a “filter” button (most often positioned close to the search functionality) which opens a separate pane that displays the provided filter options (Figure 7c).
- Search results (filtered or unfiltered) are displayed below the search box in a scrollable overview list (Figure 7d), or in a grid. A thumbnail image
- A tap on an item opens up a new pane which shows further details about the product (Figure 7e).
- A tap on a “back” button displays the overview list again. From the detail pane, the user can add the item to the shopping cart (and/or favorite list) with a tap on an “add” button.
- A tap on an item shows its detail view (Figure 7j), where the user can add the item to the favorite list.
- A check mark signals if the item is already in the favourite list (as in Figure 7f) and the “add” button is substituted by a “remove” button.

- The AirPanes interface includes the same functionality as found in conventional m-commerce interfaces.
- The design based on a scenario where the user wants to buy a camera.
- To issue a product query, the user enters a search text in a text field, as in conventional m-commerce interfaces.
- Instead of displaying overview information for each camera in the result set in a scrollable list on the screen, result items are off-loaded onto a 30×30cm in-air pane to the right of the smartphone.

- They use the Stacked layout from Study 2, and provide access to filter functionality in a second 30×30 cm pane below the results pane.
- The user can switch between these two panes by moving the in-air hand up and down, crossing an imaginary horizontal plane (as defined by the smartphone's touch-surface).
- As soon as the in-air finger enters the results pane with camera items, the user sees full information about one of the cameras (Figure 7f), depending on the position of the in-air finger.
- The camera items in the results pane are arranged in a $n \times m$ matrix with equally sized cells filling out the pane.
- An on-screen visualization with a blue cursor (inset Figure 7f) provides feedback about the in-air finger's current position within the pane.

- Filter functionality
- [YOUR TURN]

- In the third and final study, the authors measure the difference in usability between the **standard** and **AirPanes** interfaces.
- **Conclusions:** (surprise, surprise) **AirPanes** is faster for **most** operations – **filtering** seems to be cumbersome.



Design recommendations

- **Pane organization styles:** AirPanes considers a mixed pane organization, but AirPanes could be designed for one-handed use using only stacked or tiled layout (Figure 9a, 9b).
- **Usage Context:** AirPanes was evaluated with a task where the user was standing, could also be used while sitting, or when the smartphone is laying on a flat surface. In such cases, AirPanes could use the surrounding physical surface to leverage haptic feedback into mixed physical and in-air interactions (Figure 9d).



Discussion

- The authors performed three **comprehensive** studies of AirPanes potential.
- Results seem to indicate that the **AirPanes** system is a usable and viable alternative to standard interaction modalities.
- With AirPanes, the small virtual interaction surface of smartphone applications can be **extended** and **mapped** to the 3D physical space **around the device**.
- The m-commerce study confirms that AirPanes facilitates **complex analytic tasks** by reducing task time by up to 50% compared to a standard touch screen interface.