Stereoscopic Label Placement

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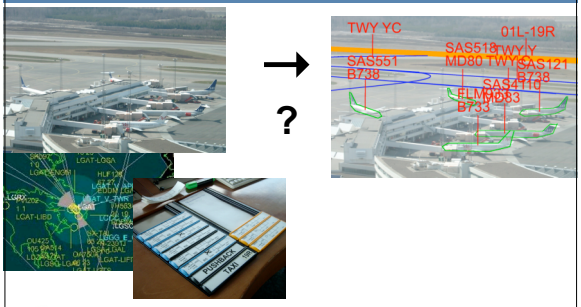
Background



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Visual Clutter

Image courtesy COAA

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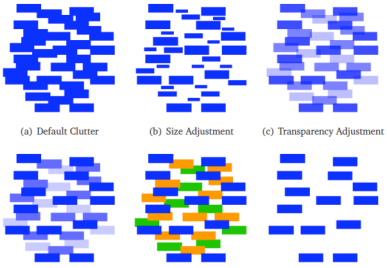
Label Modifications



(a) Default Clutter (b) Size Adjustment (c) Transparency Adjustment

(d) Intensity Adjustment (e) Color Adjustment (f) Filtering

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Label Placement

- Cartography

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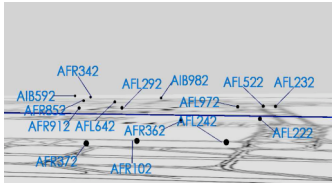
Label Placement: ”planar separation”

View



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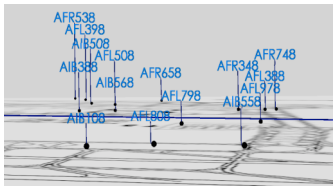
Label Placement: ”height separation”

View

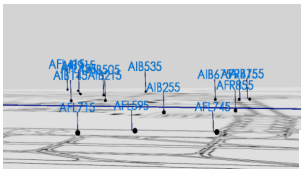


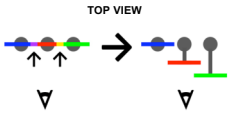
Problems

- View plane motion can cause...
  - » Disturbance
  - » Distraction – attention capture
  - » Ambiguity

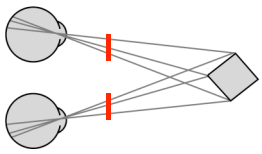
Stereoscopic Label Placement: ”depth separation”

View





Stereoscopic Disparity



Stereoscopic Displays for AR

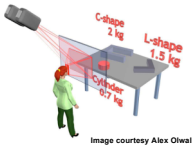
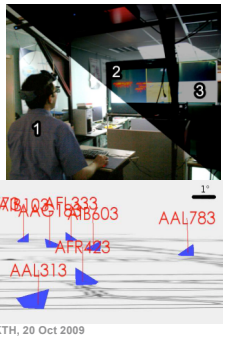


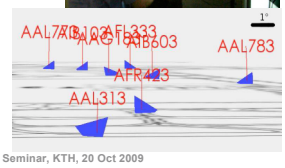
Image courtesy Alex Olwal (2005)

How is stereoscopic disparity useful in the context of label placement?

Study 1 - Setup

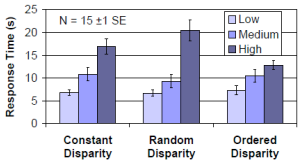
- AR setup with transparent projection screen
- Visual search task
- Main variables
  - » Object density
  - » Viewing condition
    - » Ordered disparity
    - » Constant disparity
    - » Random disparity





Study 1 - Results

- 3 levels of object density
  - » Effect seen in "high" density condition
  - » Ordered disparity 24% faster than constant disparity
  - » Random disparity slower
  - » Concept works!

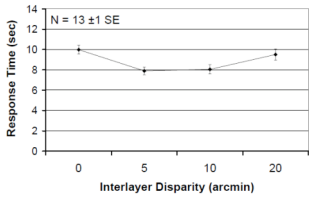


Study 2 - Setup

- Which layer separation is optimal?
- Robust against perceptual issues in AR?
  - » Brightness mismatch
  - » Contrast mismatch
  - » Accommodation mismatch
- Main variable
  - » Interlayer disparity (0, 5, 10, 20)
  - » Display mode (AR, VR)

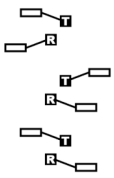
Study 2 - Results

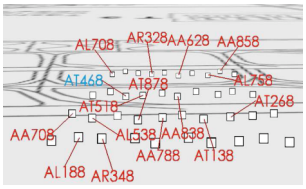
- 5-10 arcmin interlayer disparity optimal
- No interaction with display mode - robust against perceptual issues



Study 3 - Setup

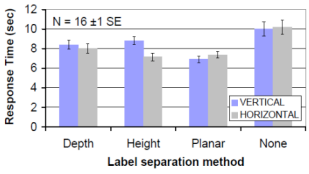
- Comparison with 2D approaches
  - » Static scene, spatial judgments





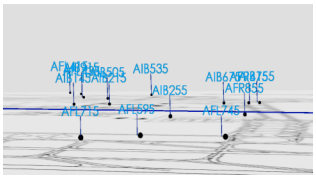
Study 3 - Results

- Similar performance improvement over control condition
- Height and planar separation affected by ambiguous placement
  - » Potentially ambiguous placements significantly slower
- Depth rated slower to read



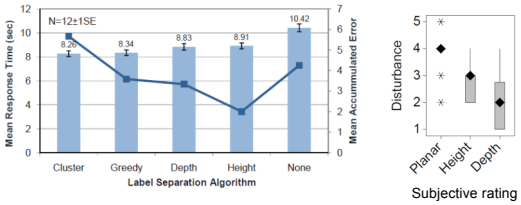
Study 4 - Setup

- Dynamic scenes, impact of motion
  - » Performance measurements and subjective ratings
  - » Depth compared to height and 2 planar algorithms (clustered & greedy)



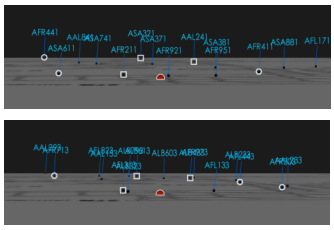
Study 4 - Results

- Again similar performance improvement over control condition
- Depth rated significantly less disturbing



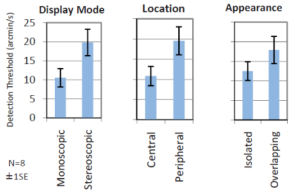
Study 5 - Setup

- Find underlying reasons to lower disturbance rating in study 4
- Establish motion detection thresholds
  - » Mono- / stereoscopic
  - » Central / peripheral
  - » Overlapping / isolated



Study 5 - Results

- Stereomotion is harder to detect – "stereomotion suppression"
- Overlapping labels are harder to detect



Summary

- Legibility of overlapping text labels is improved with depth separation
- Optimal depth spacing between layers is 5-10 arcmin disparity
- Robust against perceptual issues in AR
- User performance is comparable to 2D techniques
  - » Slower to fuse
  - » Risk of potentially ambiguous placements are avoided
  - » Motion is much less disturbing; in fact, hardly noticeable

Future Work

- Higher level of integration with ATC environment
- Other data could be included in labels
- Other application domains than ATC
  - » Stereoscopic displays are getting common – cinema, tv, home entertainment
  - » OSD depth separated from TV feed?
- Selection, and manipulation of labels in layered interface

Bibliography

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Q & A

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