Potential Issues of the Transition to Digital Displays for Safety Critical Information

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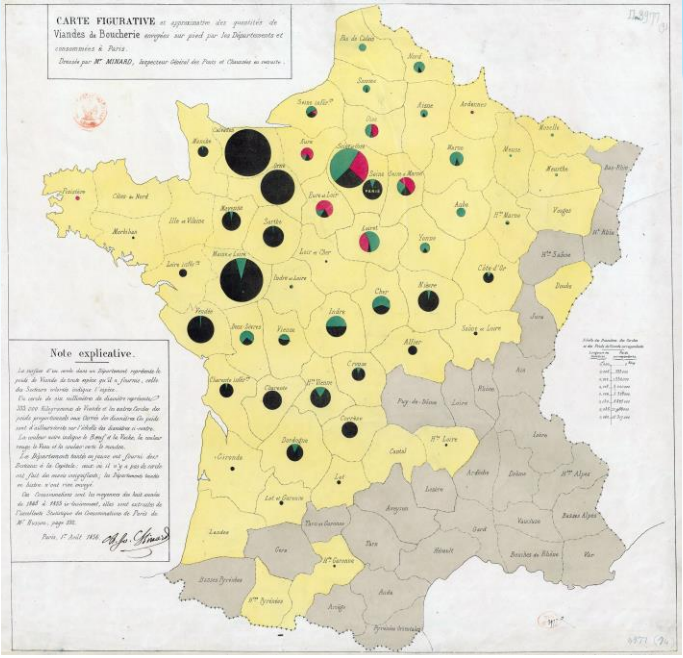
Overview

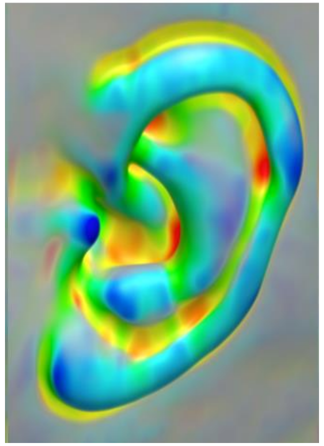
- Visualization basics
  - What is vis.?
- Transition to digital
  - Physical vs. digital
- Potential issues
  - Reliability
- Possible solutions
  - Ongoing research

Visualization Basics I

- Idea: convey info. visually
  - Digitally, on paper, mechanically, …
- Different kinds
  - Interactive, noninteractive, …
  - Scientific vis., data vis., info vis., …
- Different goals
  - Build hypotheses
  - Make decisions
  - Educate
  - …



[1]



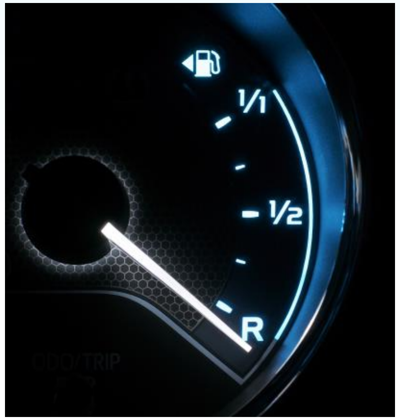
[2]

Visualization Basics II

- Very active area of research
  - Part of data science / AI / ML
  - New types of data
  - Larger amounts of data
  - New contexts
  - Better ways to present data

Visualization Basics III

- Focus here: safety critical data vis.
  - Esp. in civilian and military automobiles, aircraft
  - Traditionally displayed w/ physical indicators
  - Time sensitive
- Ex:
  - Speedometer
  - Temperature gauge
  - Fuel gauge
  - Altimeter
  - …



[3, 4, 5]

Visualization Basics IV

- These vis. are safety critical
- Thus, reliability is critical:
  - Even short duration outages are unsafe
  - Failures difficult to resolve
    - Can’t just swap out dashboard while driving

Transition to Digital I

- Recently, move from physical to digital displays
  - Replace physical indicators w/ digital vis.
    - Often, replace multiple indicators with one display
  - Automobiles: digital cockpit
    - Expected to be norm by 2030 [6]
  - Aircraft: glass cockpit
    - Already present in many aircraft

Transition to Digital II

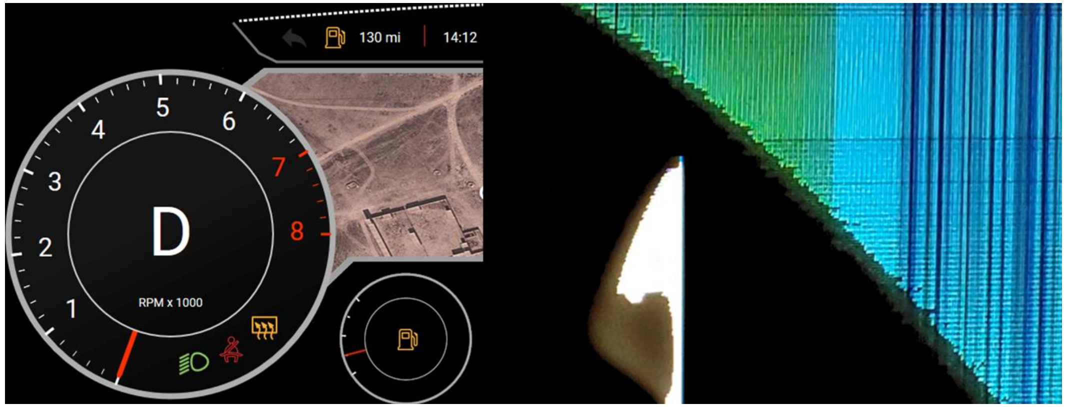
- Digital displays: many advantages [7]
  - More versatile
    - Vis. different data at different times
    - Change vis. style
    - Change vis. location
  - Cheaper
  - Less maintenance

Transition to Digital III

[8,9]

Potential Issues I

- Multiple physical indicators → one display
  - Multiple points of failure → single point of failure
- Failure of one display: more missing data
- Damage to one display: more missing data
  - Additional implications for touchscreen



Potential Issues II

- Digital displays: higher info density
- Harder to view under adverse environ. conds.
  - E.g., smoke, intense vibrations, occlusion

[8]

Possible Solutions I

- Some obvious potential solutions exist:
  – Redundant digital displays
    - E.g., Garmin G1000 reversionary mode
  – Both digital and physical indicators
- However, other issues arise:
  – Space limitations
  – Weight limitations
  – Cost limitations
  – Time limitations

Possible Solutions II

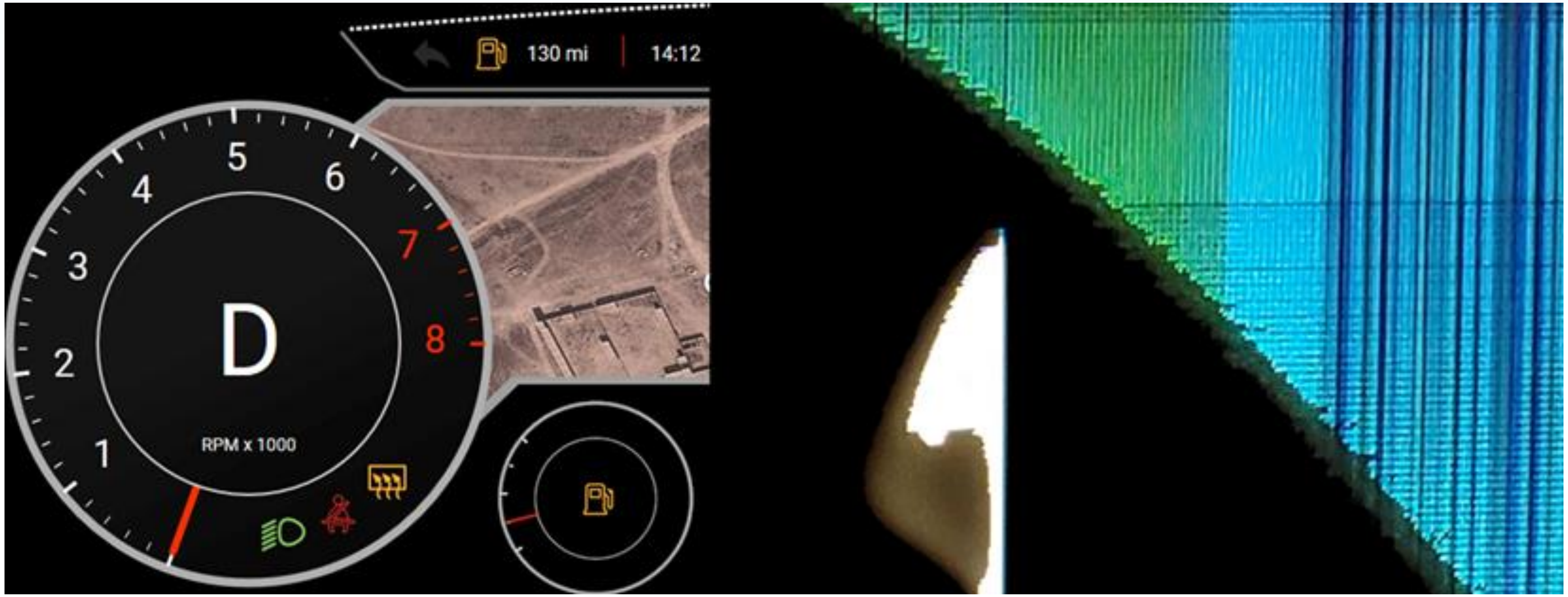
- Our proposed solution:
  - Automatically analyze functionality / visibility of display
    - E.g., detect non-working regions of display, environmental issues
  - Adjust vis. to ensure visibility
    - E.g., if right-hand side of display failed, display critical info. on left side
  - Change presentation as necessary
    - E.g., if dial won’t fit, switch to numeric

Possible Solutions III

- Ex: Consider a working digital cockpit display

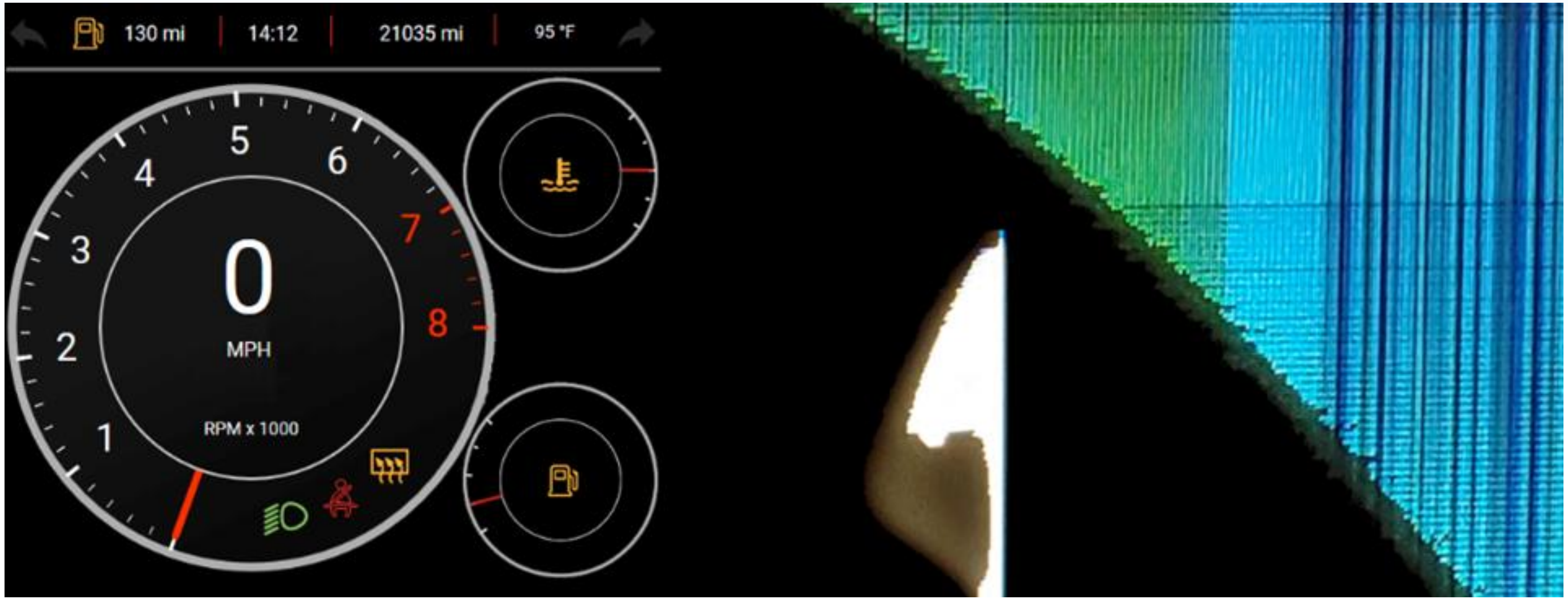
Possible Solutions IV

- Vs. a damaged one



Possible Solutions V

- Vs. one where the damaged region is detected and the display responds



Possible Solutions: Ongoing Research I

- Current research project:
  - Automated detection of display / environmental issues
    - Cheap, off-the-self sensor(s)
      - Analyze visibility of display regions
    - Easy retrofitting of hardware (no display modification)
  - Automated response to detected issues
    - Occlusion
    - Display failure
    - Display damage
    - Environmental conditions

Possible Solutions: Ongoing Research II

- Advantages:
  - Automated (and fast!) failover
    - Uninterrupted viewing of data
    - Distraction free
    - Beneficial even when redundancy present
  - Account for scenarios obvious solutions don’t
    - Environ. conditions
  - Potentially obviate need for redundancy

Conclusions

- Safety critical info moving to digital
- Fewer digital displays vs. traditional
  - Maybe single point of failure
- Digital displays more versatile
- Possible to detect failure
- Possible to adjust for failure

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