Examples of ‘interesting’ HMI's that enhance/influence situation awareness from University of Nottingham research

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Case study areas

1. Digital mirrors in vehicles
2. Augmented Reality Head-Up Displays
3. Natural Language HMIs
4. HMIs for highly automated driving
CASE STUDY 1: Digital mirrors

• Replacement of traditional mirrors with camera-based displays:
  – Fuel economy savings
  – Remove blind spots/enhance field of view
  – Can augment images to enhance situation awareness
Digital mirrors - Key research questions

• Where should digital mirror displays be located? *
• Augmentation of digital mirrors – what additional information / cues can be provided? **
• Depth perception – what are the implications of alternative digital mirror displays for distance judgements (absolute and relative)? **
• What happens when a digital mirror fails? Are there ‘safe’ failure modes?
• Gap acceptance studies – will removing the mirrors affect a driver’s perception of the width of their vehicle?


Configurations used in driving simulator study – Large et al., 2016

**Baseline (BL)** – Mirror displays in traditional set up within and outside the vehicle

**Configuration 1** – Displays placed in traditional mirror locations

*Although this is of little practical interest it will provide a direct comparison between display formats – traditional mirror versus digital screen*

**Configuration 2** – Displays placed within vehicle close to their baseline locations
Configurations, continued

**Configuration 3** – Offside display placed near baseline location; Rear and nearside display integrated and placed in centre console in horizontal alignment

**Configuration 4** – Nearside display immediately to left of steering wheel; Rear view display in cluster (with speedometer visible to left); Offside display immediately to right of steering wheel

**Configuration 5** – All three displays integrated within the centre console
Method

• 38 participants
• Six conditions, within-participants design
• Each configuration tested in a separate simulated drive
  • Scenario ~6 minutes long, preceded by a familiarisation drive (~2.5 minutes)
  • 3-lane motorway with 9 prescribed lane change manoeuvres
  • Baseline always first (session 1), rest of conditions in randomised order (session 2)
  • Practice drive at start for familiarisation with simulator
• Participants instructed to perform each manoeuvre in sequence at a predefined distance through the scenario by a recorded audio message
  
  “Move into the middle lane when it is safe to do so”
  
  “Move into the outside lane and then back into the middle lane to overtake the car in front when it is safe to do so”
Driving performance: Mean time to lane crossing

Significant effect of configuration,
\( F(5,145) = 2.436, p < 0.05 \)

Significant differences between Baseline and C#1, C#2, C#3, C#4, \( p < 0.05 \)

Mean Time to lane crossing, s

Baseline: 10.9s, Configuration 1: 10.1s, Configuration 2: 10.1s, Configuration 3: 10.0s, Configuration 4: 10.1s, Configuration 5: 10.3s

Error Bars: +/- 1 SD
Eye Tracking: Heat maps - aggregated results
Study addressing situation awareness with AR HUDs *

- Can landmark-based navigation within an AR HUD reduce navigational decision time and enhance navigational success compared to a conventional distance-to-turn approach?
- Can AR enhance potentially ‘poor’ landmarks increasing their usability and utility as ‘good’ navigational landmark candidates?

Results – Navigation Errors

![Bar graph showing success rates for different navigation methods.]

- Conventional
- AR arrows
- Landmark arrows
- Landmark boxes

Success Rate
Results – Eye Movements (participant 20)
Visual heat maps for different HUD displays
CASE STUDY 3; Natural language HMIs

• Conversational agents have considerable potential in vehicles
  – Eye/hands free
  – Natural dialogue style for humans
  – Engaging dialogue style for humans
  – May enhance situation awareness in specific situations

• But robust natural language systems do not exist
• Power of Wizard of Oz approach…. See *

CASE STUDY 4: Highly automated driving

• Need for ‘driver’ to understand the current status of the vehicle in partial/highly automated driving
• The majority of studies in this area are short-term one-off exposures to automation in a vehicle

• What tasks do occupants of a highly automated vehicle carry out?
• To what extent do they monitor a situation awareness HMI?
• How does this change throughout an extended (one week) exposure?