Voice Search “Shortcuts” for In-Car Infotainment

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Last minute speaker change courtesy of volcanic activity, originally

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Context of this talk

• MERL is one of the research labs of Mitsubishi Electric
  – (Not Mitsubishi Motors!)

• MERL speech group focus:
  – Pre/Post processing of speech and audio
  – UI design that can improve the usability of speech interfaces.

• Usability ≠ ASR performance
  – ASR performance affects UI design.
  – UI Design affects ASR performance.
Focus on Push-to-Talk
State of the Art

• Say anything, anytime? Not exactly.
• System must be told when to listen
• Single push-to-talk (PTT) button launches a dialog
• Content “silos” improve accuracy
  – Single-shot approaches are emerging, but thus far are domain-restricted.
What Else are Buttons Good For?
Contextual Push-to-Talk

• *Any* button can be a “listen” button
  – Just tap twice instead of once

• Choice of button provides context to ASR engine
  – Search *what*
  – Shuffle *what*
  – Call *whom*

• Advantages:
  – Skip dialog steps
  – Exploit motor memory
  – Augment rather than replace existing UI
Experimental Validation

• Research Question:
  – Are multiple, contextual push-to-talk buttons better than the conventional, single-PTT approach?

• Hypotheses:
  – Multi-PTT allows for faster task completion.
  – Driving performance and visual attention using Multi-PTT are no worse than Single-PTT.

• Setup:
  – MERL Driving Simulator
  – Eye tracker (Seeing Machines’ FaceLAB)
  – 18 subjects (all tried both interfaces and drove a control session)
Experimental Results

• No significant difference between Single- and Multi-PTT in steering or lane keeping
• Significant differences found:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Single-PTT</th>
<th>Multi-PTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance in following distance (lower is better)</td>
<td>106.7</td>
<td>42.3</td>
</tr>
<tr>
<td>Glances away from forward roadway (avg. per task)</td>
<td>11.2</td>
<td>7.9</td>
</tr>
<tr>
<td>Workload (NASA Task Load Index)</td>
<td>55.2</td>
<td>49.1</td>
</tr>
<tr>
<td>→ control session (driving only) rated 29.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean task time (seconds)</td>
<td>26.5</td>
<td>15.8</td>
</tr>
<tr>
<td>Mean task error rate</td>
<td>8.8%</td>
<td>4.2%</td>
</tr>
</tbody>
</table>

• Questionnaire results: 78% of subjects would prefer using the Multi-PTT variant in their cars
Experimental Results – Mean Task Time

- Single-PTT: Approximately 25 seconds
- Multi-PTT: Approximately 15 seconds

The graph shows a significant difference in mean task time between Single-PTT and Multi-PTT.
Experimental Results – Mean Task Error Rate

![Bar graph showing mean task error rate for Single-PTT and Multi-PTT. The error rate for Single-PTT is significantly higher than for Multi-PTT.](image-url)
Experimental Results – Variability in Following Distance

The graph shows the following distance variance difference in meters squared between Single-PTT and Multi-PTT systems. The Single-PTT system has a significantly higher variance difference compared to the Multi-PTT system.
Experimental Results – Eye Gaze and Workload

![Graphs showing mean number of glances and mean NASA TLX score for different conditions.]

- Mean Number of Glances:
  - Short: Single-PTT > Multi-PTT
  - Medium: Single-PTT > Multi-PTT
  - Long: Single-PTT = Multi-PTT

- Mean NASA TLX Score:
  - Control: Low
  - Single-PTT: High
  - Multi-PTT: Moderate

$x < 0.5$ sec  $0.5 < x < 2$ sec  $x > 2$ sec
Summary

• We proposed and validated multiple, contextual PTT buttons.

• Interaction durations were reduced, and more attention was paid to the driving task at hand.

• The design is simple and intuitive.
Acknowledgements

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For more details, please see our upcoming publication: