

Automotive Speech Interfaces: Design Implications from Academic Research

Andrew Kun



UNIVERSITY *of* NEW HAMPSHIRE

Tim Paek

Microsoft®
Research

Our Collaborators



- Zeljko Medenica
- Nemanja Memarovic
- Oskar Palinko
- Jon Oppelaar
- Alex Shyrovkov

- Yun-Cheng Ju



Why do care about automotive?



Americans spend 100+ hours a year commuting!

[US Census Bureau]



Speech services offered

- Voice dialing
- Turn-by-turn directions
- Infotainment (e.g., music)
- Directory assistance
- Voice search
- SMS
- ... (more to come)

Why is speech the preferred modality?



Hands-free, eyes-free interaction

Laws now prohibit use of mobile devices without a “hands-free” kit



Do speech interfaces always keep users focused on the primary task of driving?



If not, are there design guidelines we can follow to keep users focused?



Academic Questions with Practical Import



- How does recognition accuracy affect driving performance?
- Does it matter where you place the push-to-talk button?
- How should speech be used for turn-by-turn directions in personal navigation devices (PND)?

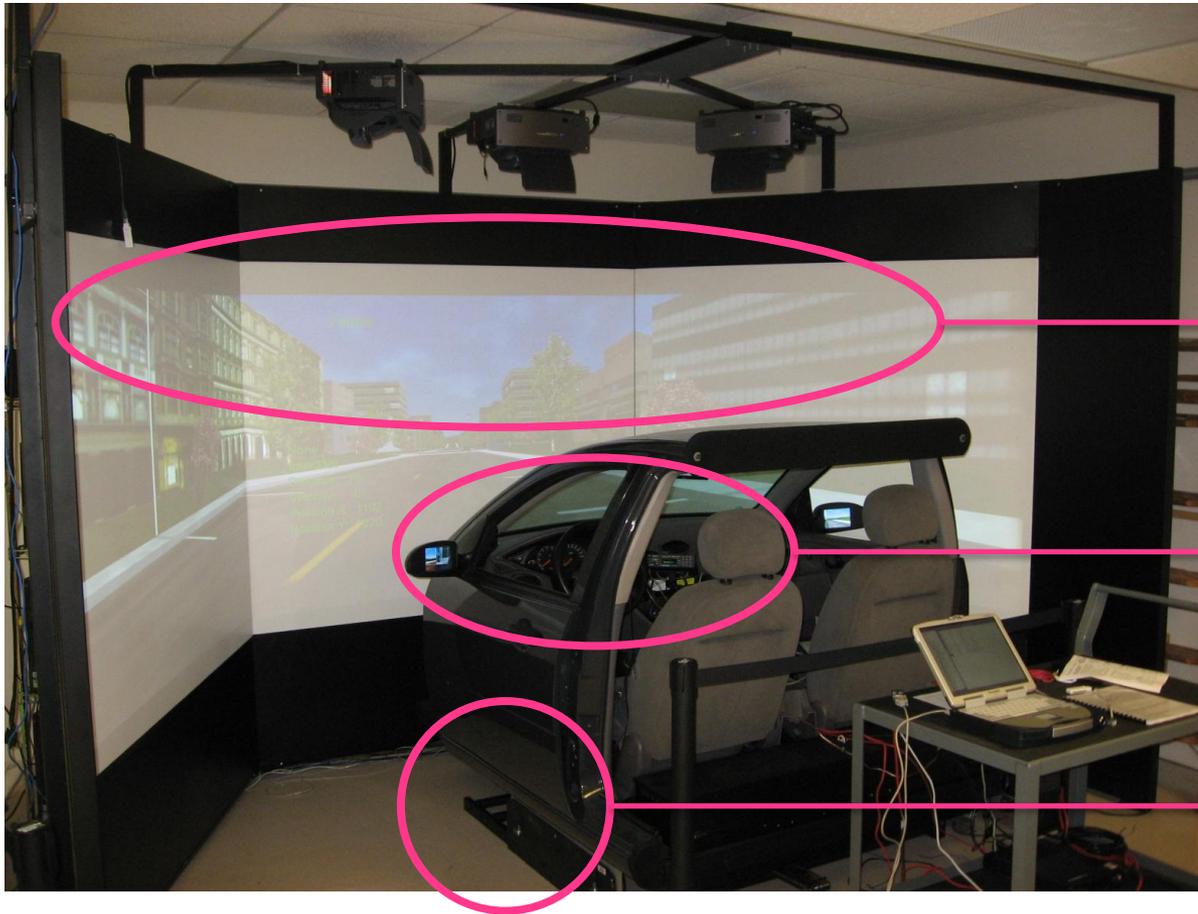
Goal: Keep users and others safe

Academic Questions with Practical Import



- How does recognition accuracy affect driving performance?
- Does it matter where you place the push-to-talk button?
- How should speech be used for turn-by-turn directions in personal navigation devices (PND)?

Conducted driving simulator study

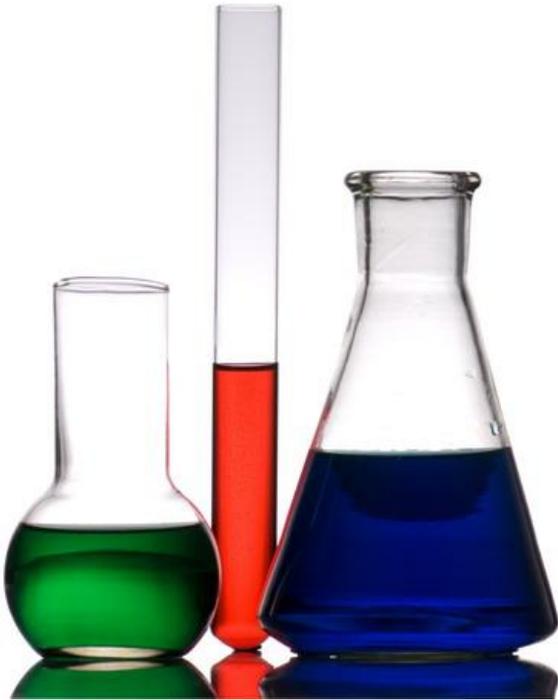


180° field of view

Front seat interior
with rear view
and side mirrors

Motion base

Experiment: Procedure

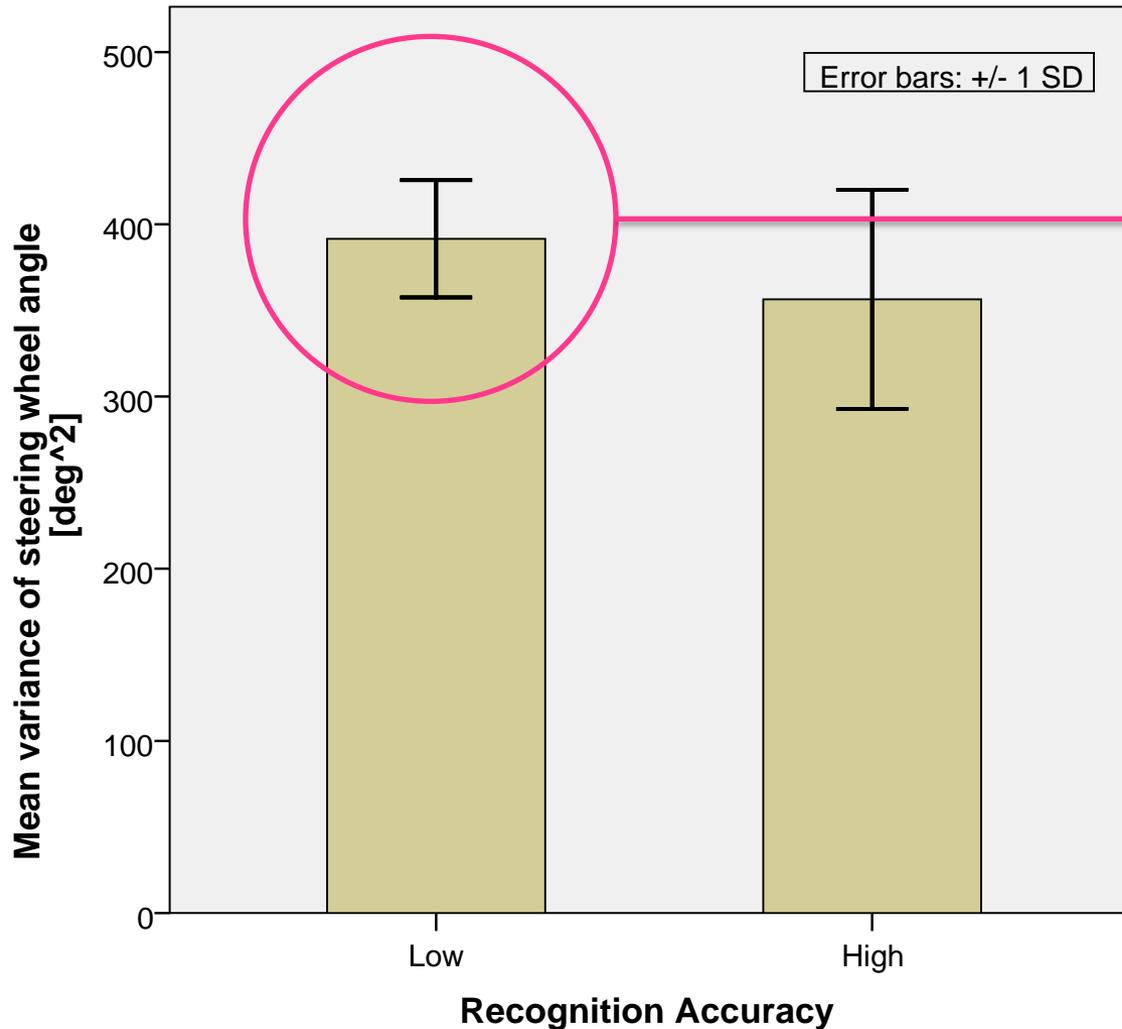


- **Primary task:** Following a lead vehicle
- **Secondary task:** Command-and-control interaction with radio system
 - Users first received command which they then produced
- No real recognition
- 20 participants

Experiment: Variables

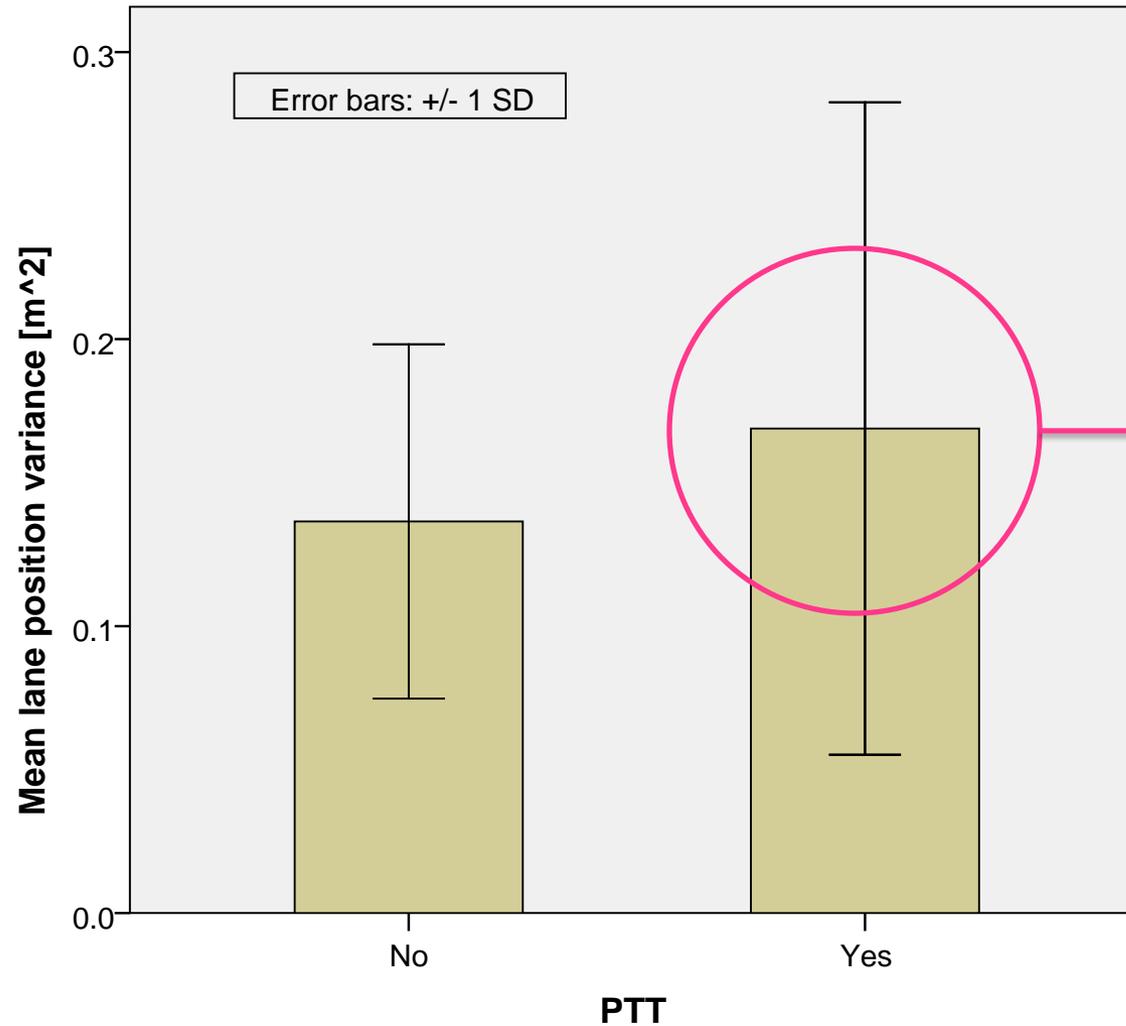
- Controlled speech interface variables
 - **Recognition Accuracy**: High (90%) vs. Low (45%)
 - **PTT button**: Center steering wheel vs. ambient
 - **Dialog repair**: Misunderstanding vs. Non-understanding
- Measured driving performance variables
 - **Lane position variance**: Most dangerous
 - **Steering wheel angle variance**
 - **Velocity variance**

Accuracy Affects Steering Wheel Angle



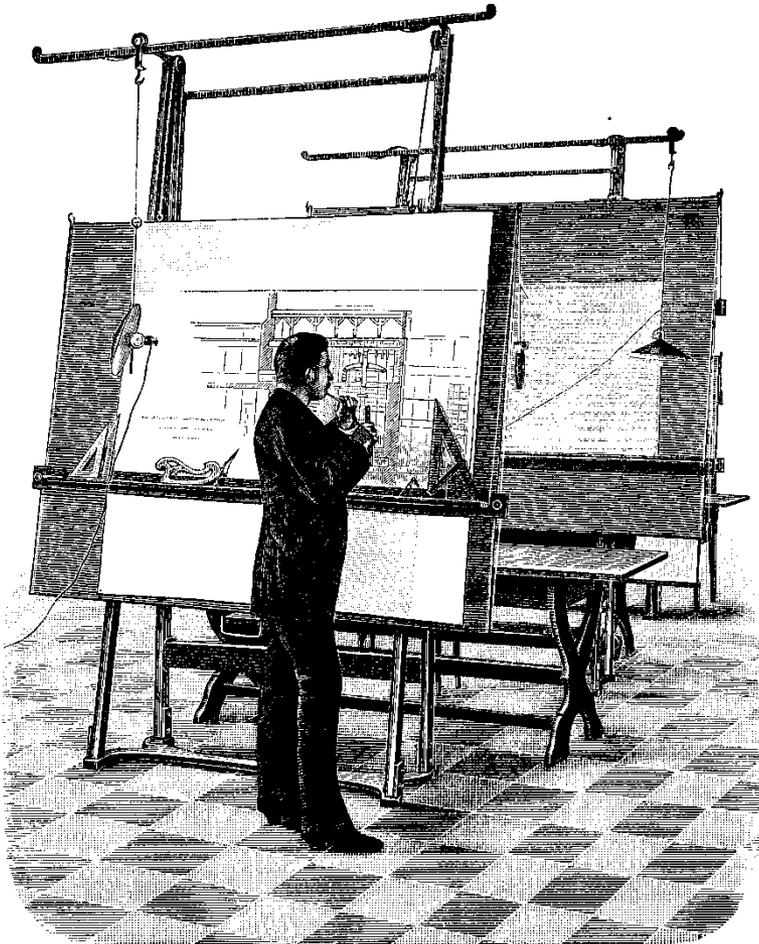
Errors may be causing distractions for users

Low Accuracy + PTT Affects Lane Position



Users may be trying to fix low accuracy

What does this mean for designers?



- A **hands-free, eyes-free** interface does **not** guarantee that driving will be **distraction-free**
- How users interact with the interface during errors is crucial
- Interface properties seem to matter less when accuracy is high

Academic Questions with Practical Import



- How does recognition accuracy affect driving performance?
- Does it matter where you place the push-to-talk button?
- How should speech be used for turn-by-turn directions in personal navigation devices (PND)?

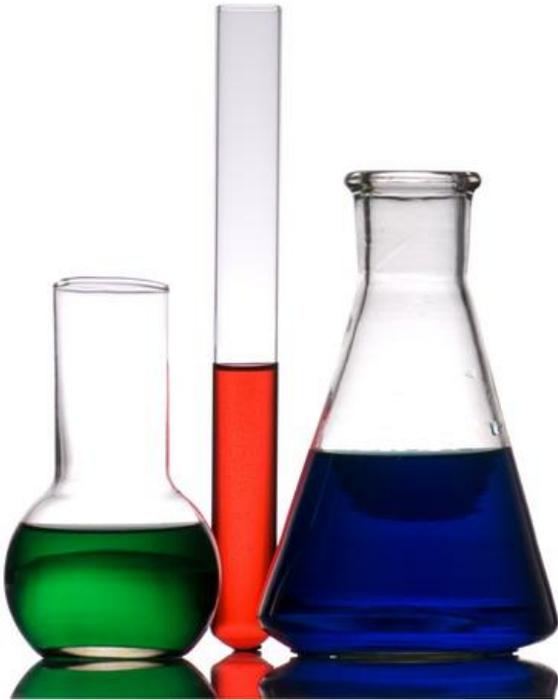
Conducted driving simulator study



Eye-tracker

Video cameras

Experiment: Procedure



- **Task:** Follow turn-by-turn directions to destination
- Compared 2 conditions:
 1. Standard PND (visual display + voice)
 2. Just voice
- Simple within-subjects factorial design
- 8 participants

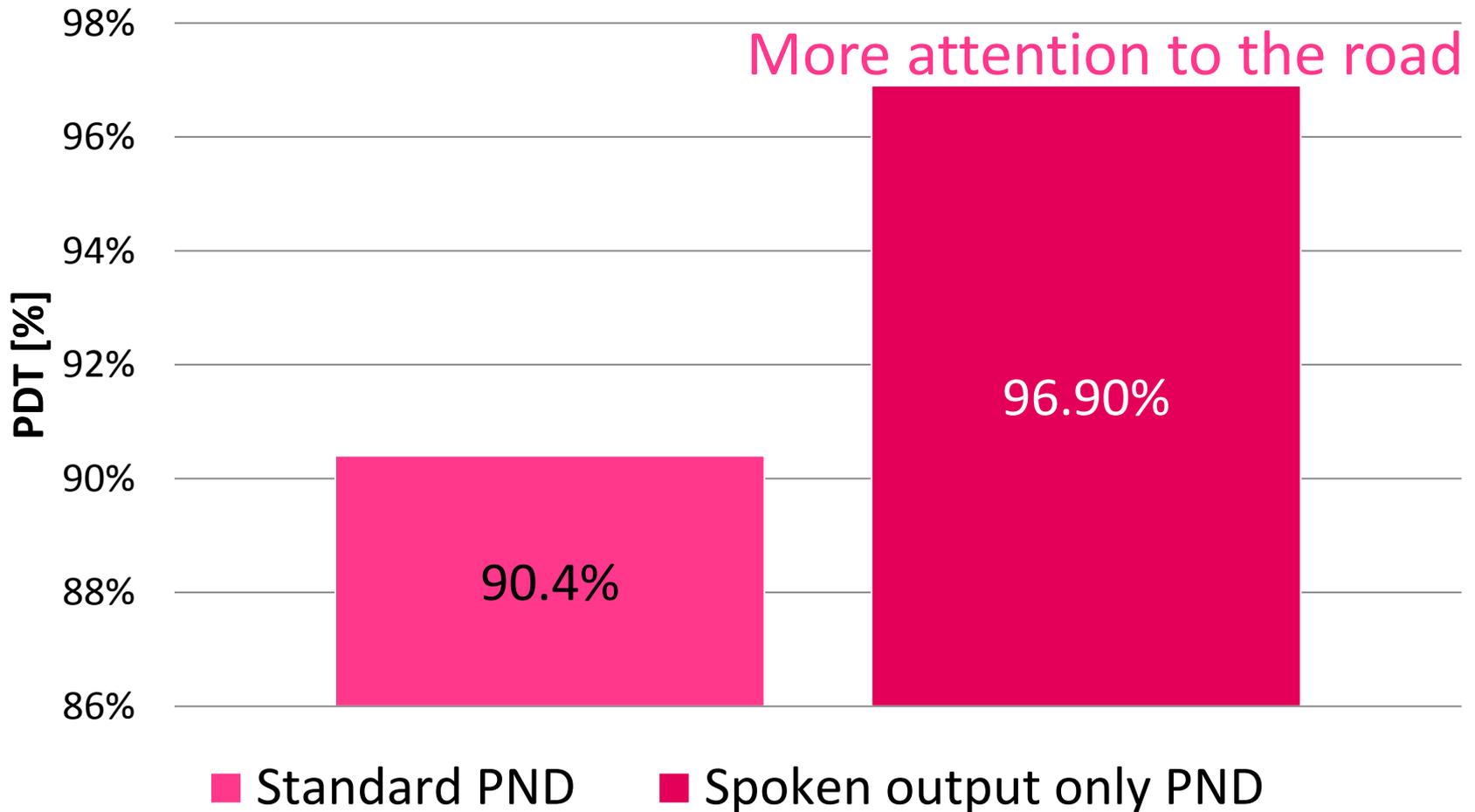
Experiment: Variables

- Measured driving performance variables
 - Lane position variance
 - Steering wheel angle variance
 - Velocity variance
- Collisions
- Visual attention
 - Fixations (> 100 msec): number, timing, etc.
 - Percent dwell time (PDT) on road
 - Cross-correlation peaks: Instantaneous correlations between PDT and driving performance variables

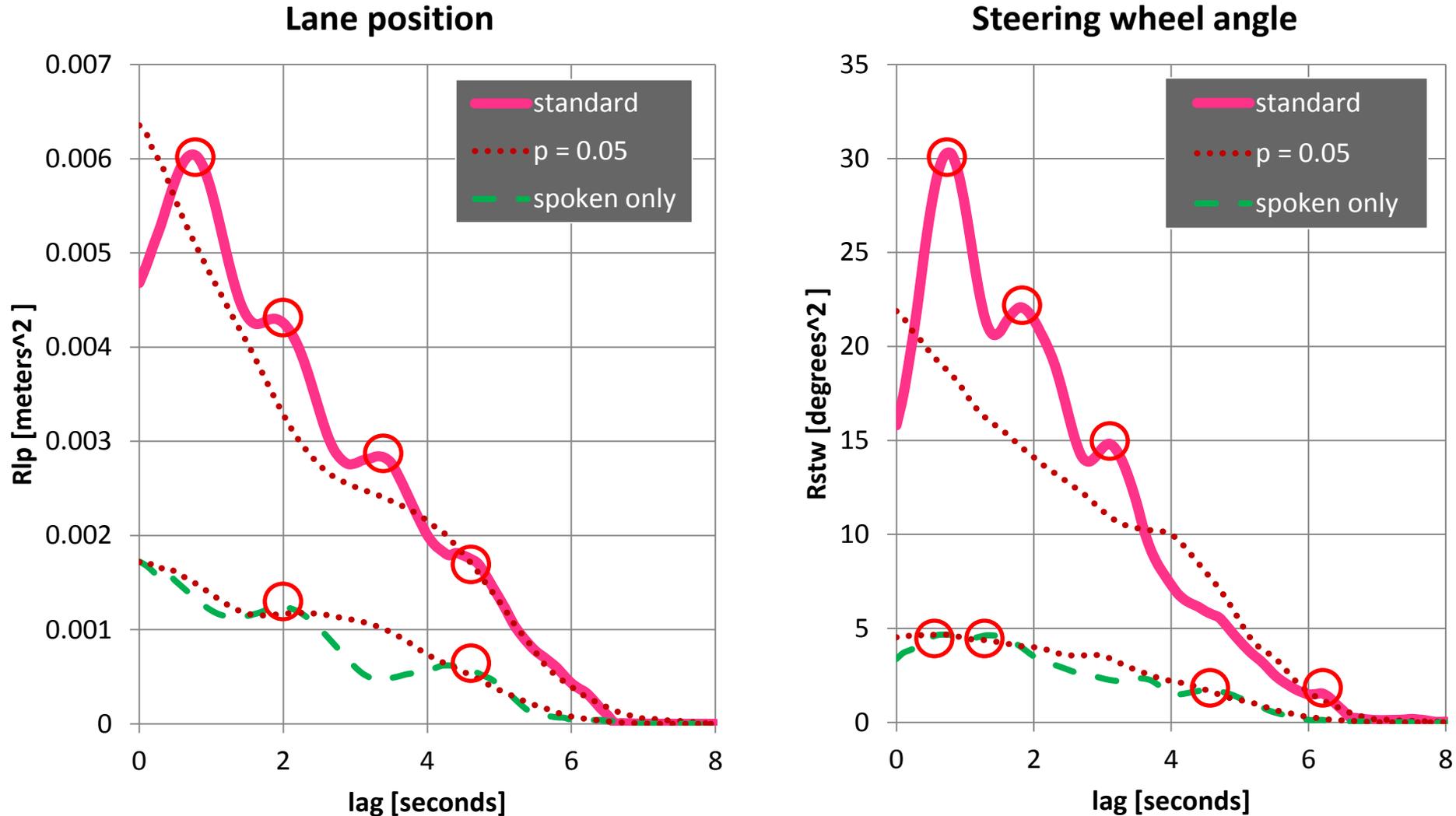
Standard PND

Voice only PND

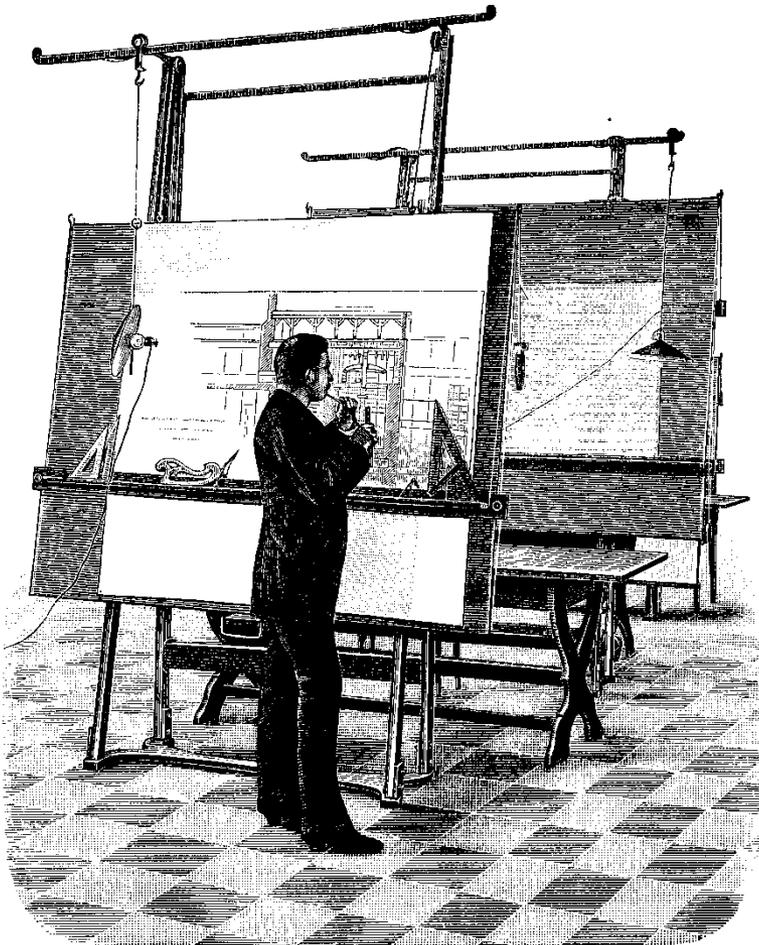
More PDT on road with voice only



Looking away from road correlated with quick lane position and steering wheel angle variance



What does this mean for designers?



- If users can trust GPS directions, having just spoken output helps users stay more focused on the road
- Small form-factor devices better off turning off their tiny displays
- For voice only PND, it's useful to provide spoken confirmations after turns

Review of Academic Questions



- How does recognition accuracy affect driving performance?
- Does it matter where you place the push-to-talk button?
- How should speech be used for turn-by-turn directions in personal navigation devices (PND)?



Questions?

Feel free to contact:

andrew.kun@unh.edu

timpaek@microsoft.com

Bibliography

- A. Kun, T. Paek & Z. Medenica. The effect of speech interface accuracy on driving performance. *Proceedings of Interspeech*, 2007.
- A. Kun, T. Paek, Z. Medenica, N. Memarovic & O. Palinko. Glancing at personal navigation devices can affect driving: Experimental results and design implications. *Proceedings of Automotive UI*, 2009.