Passive Demonstrations of Light-Based Robot Signals for Improved Human Interpretability

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Building-Wide Intelligence Project
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Building-Wide Intelligence

- Real-world deployment
- Fleet of autonomous service robots
  - 5 (soon to be 7!)
- Respond to verbal commands
- Intended to provide services to the building's occupants

Navigating Crowded Spaces

- The robots navigate crowded hallways
- This can lead to navigational conflicts where the robot and person want to walk into the same place.

The Hallway Problem

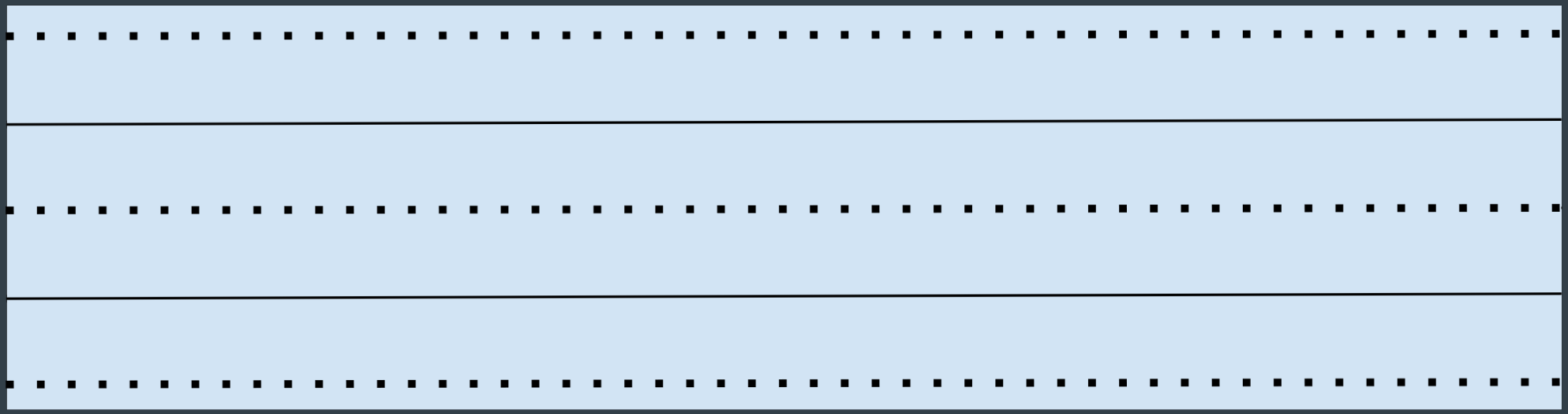
Solution: LED Turn Signals

Right Turn

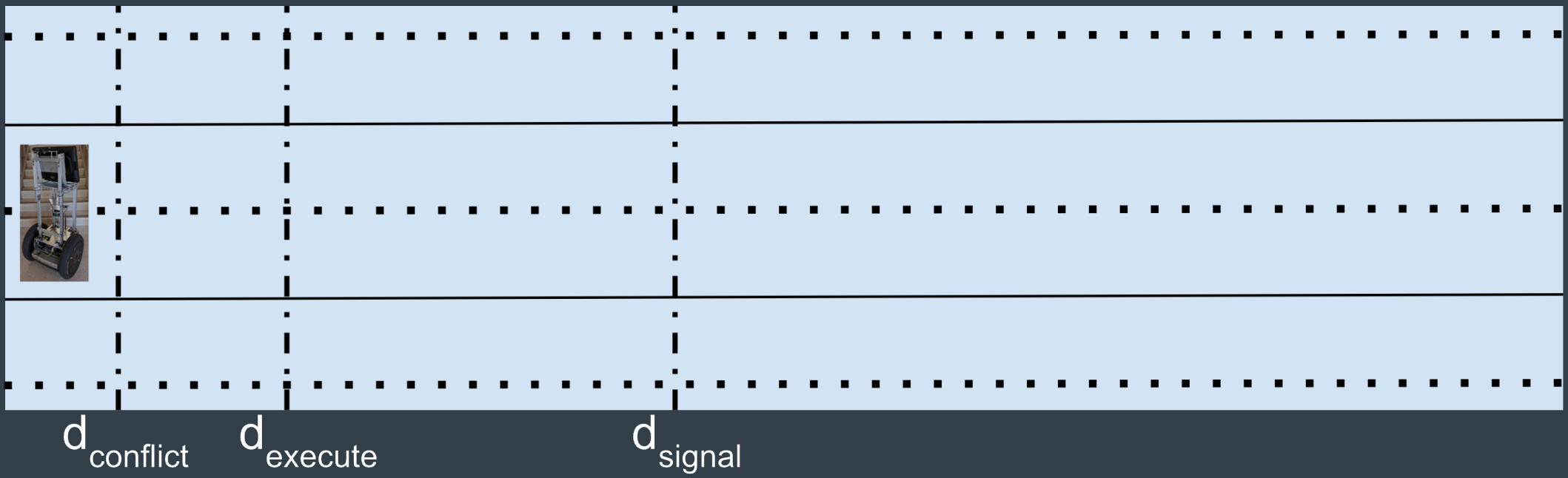
Left Turn

Hallway Test Environment

Modeling the Hallway – 3 Traffic Lanes



Robot Behavior



- Hallway – 17x1.85 meters
- Signal – 7 meters from the person
- Execute – 2.75 meters from the person
- Conflict – 1 meter from the person

Pilot Study

- 13 participants (9 male, 4 female)
  - Recruited primarily from the UT Austin Engineering and Computer Science.
- Procedure
  - Informed consent & media release
  - Participants walked once down the test hallway with the robot going the opposite direction
  - Survey
- Results
  - Half interpreted the signal the direction they should take.
  - Half interpreted the signal like a turn signal.

New Approach – Passive Demonstration

- Want to demonstrate the signal with no explicit training period.
- Idea – Passive Demonstration
  - Have the robot use the signal in context before it is explicitly needed in the interaction with the participant.
- Robot makes a lane change at the start of the hallway.

Study Design

Study Conditions			
		Passive Demonstration	
		No Demonstration	Demonstration
LED Signal LED	No LED	No Demonstration, No LED	Demonstration, No LED
	LED	No Demonstration, LED	Demonstration, LED

Study

- 47 Participants (39 male, 8 female)
  - Recruited primarily from the UT Austin Engineering and Computer Science.
- Procedure
  - Informed consent & media release
  - Participants walked once down the test hallway with the robot going the opposite direction
  - Survey
- Additional 11 participants (8 male, 3 female) recruited for a follow-up condition.

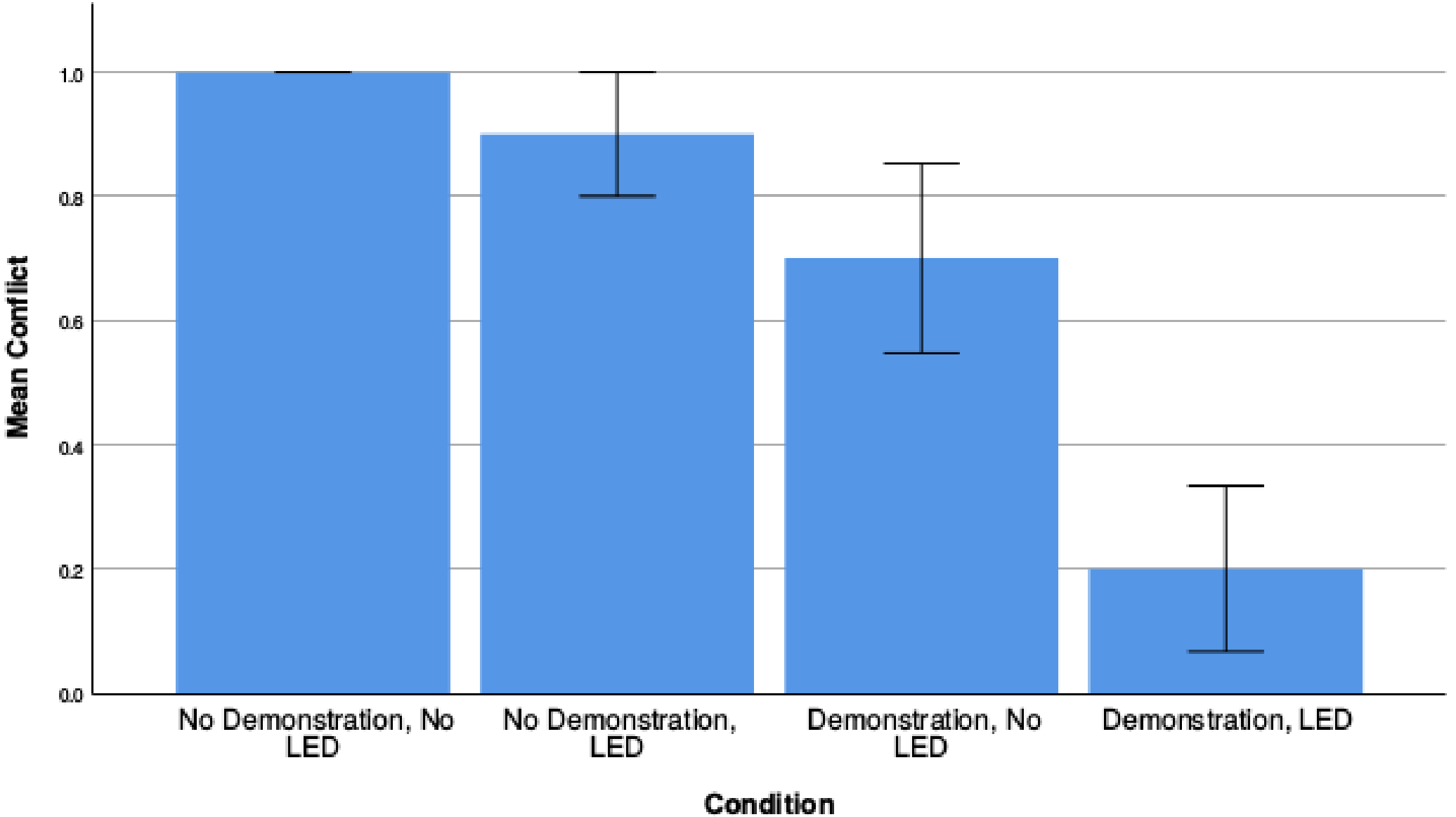
No Demo, No LED

No Demo, LED

Demo, No LED

Demo, LED

Passive Demonstrations Reduce Conflict



Conclusion

- We thought the meaning of the LED turn signals would be obvious to users.
  - It was not.
- Introduction of the concept of the passive demonstration of the signal.
  - Effective in demonstrating the meaning of the signal to users.