Towards Natural Dialogue with Robots: Bot Language

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Objectives

- Exploring methods that change the role of robots from *Tools* to *Teammates*
- Collect human-robot dialogue training data that is computationally tractable without sacrificing naturalness
  - Task: Commander (naïve participant) instructs a robot in a remote location to navigate through an indoor environment, under network constraints
- Collect data containing natural language interactions & associated multimodal data from robot
  - Task: Human "teammate" is engaging in dialogue with a robot "teammate"

Our vision includes natural, intuitive bi-directional communication between human teammates and robots using language. Multimodal spoken dialogue will be a key component.
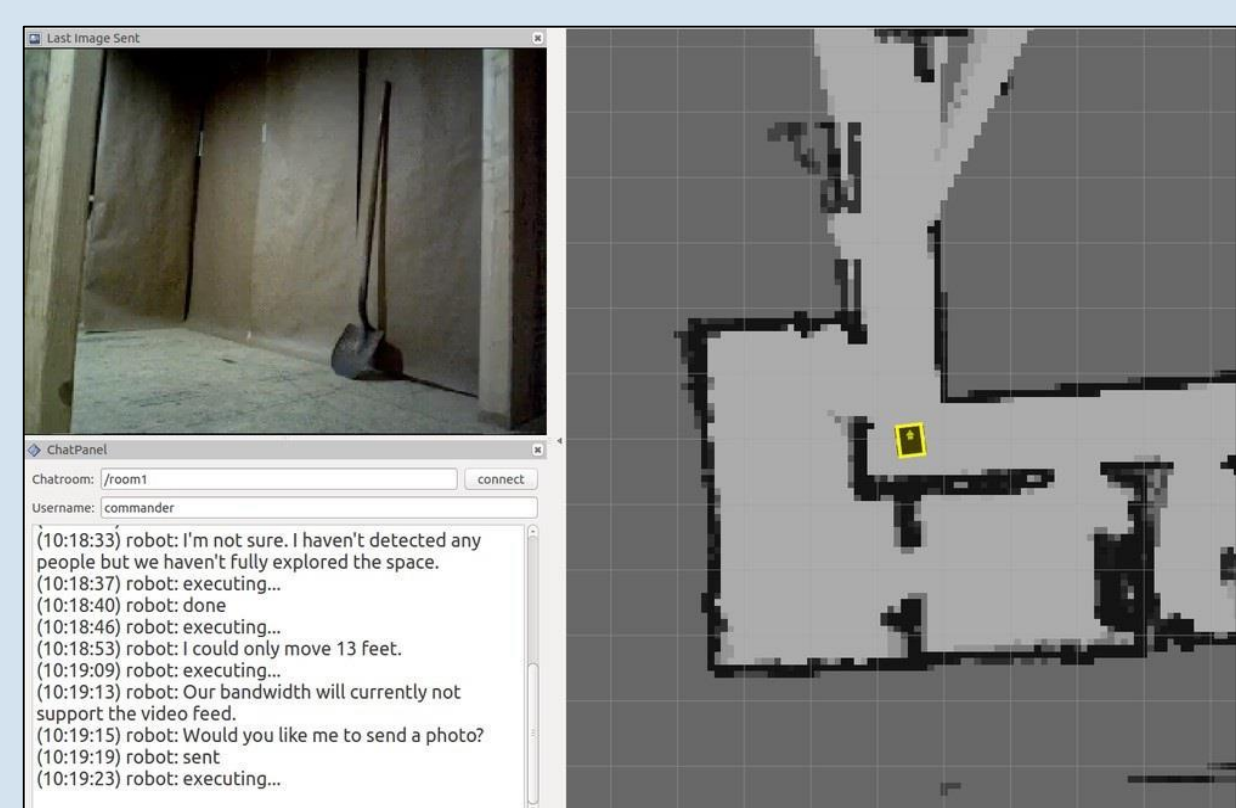
Approach

- Start with human wizards using "Wizard of Oz" method as stand-ins for components to be automated
- Use two wizards representing separable, automatable functions:
  - Dialogue Manager (DM-Wizard) is the "brains" of the robot in natural language interactions
  - Robot Navigator (RN) controls robot based on instructions from DM-Wizard, passed on from Commander
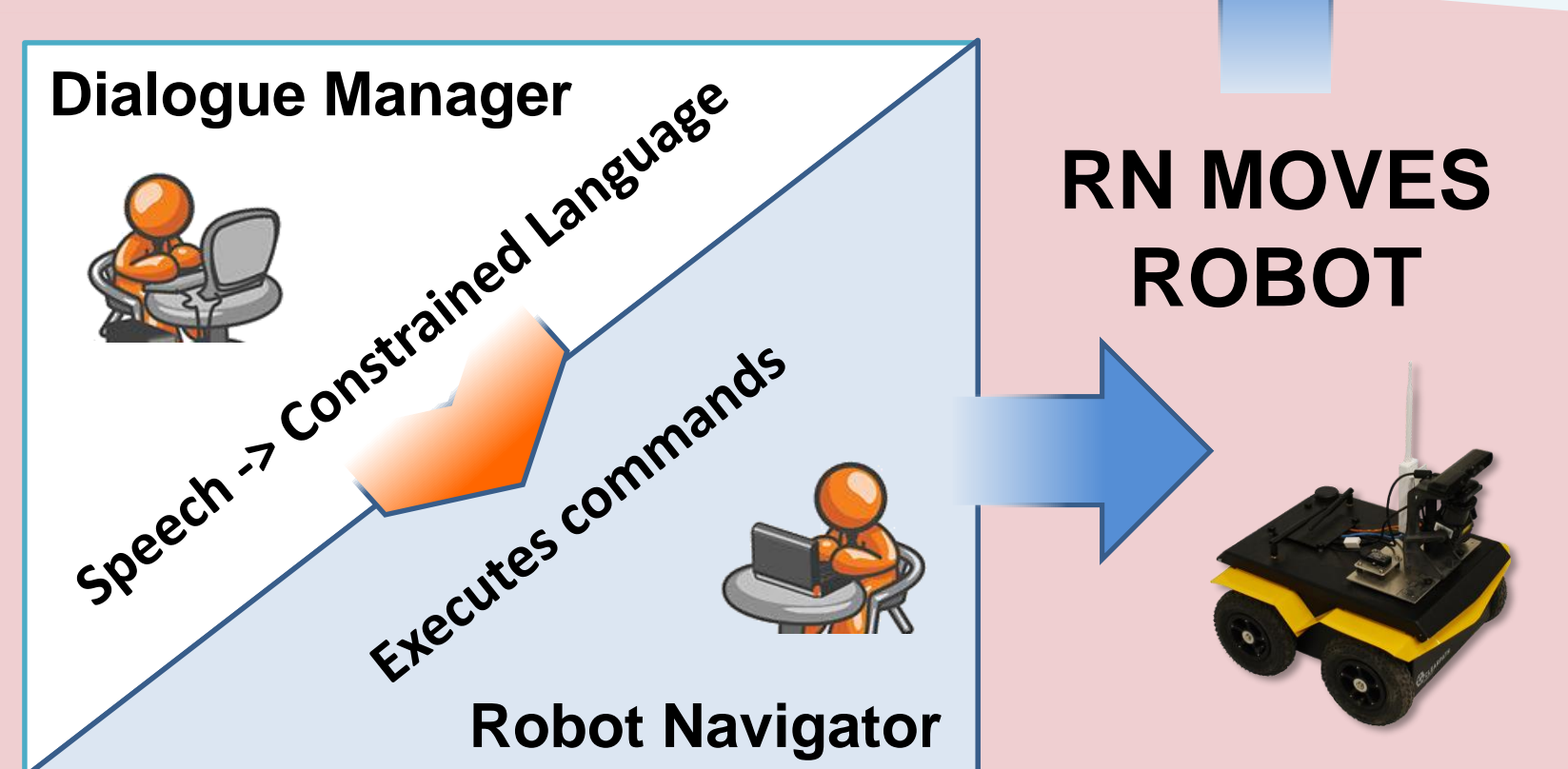

Commander Participant

VIEWS

VERBAL COMMANDS

Dialogue Manager

Speech -> Constrained Language

Executes commands

Robot Navigator

"Behind the scenes"

RN MOVES ROBOT

Adaptation of "Wizard of Oz" methodology for multimodal human-robot dialogue.

Multi-Phase Development

Phase 1: Exploratory data collection (completed)
- DM-Wizard communicates via chat windows with both Commander & Robot Navigator, who communicate with each other only via DM-Wizard
- Commander provides unconstrained instructions (e.g., "go through the doorway on the right")
- DM-Wizard follows guidelines for effective communication iteratively developed throughout phase 1, but is relatively unconstrained in the messages typed to Commander
- Recruited ten "Commander" participants to each participate in three twenty-minute trials

Participant speaks (audio)	Participant <--- DM chat room 1 (text)	DM ---> Robot Navigator chat room 2 (text)	Navigator speaks (audio)	ROBOT on screen
move forward				
	I'm not sure where or when to stop if I move forward.			
move forward 3 feet				
		move forward 3 feet	<navigate>	[motion]
			done	
	done			

The Commander Participant provided an open-ended instruction. The DM-Wizard intervenes to determine an endpoint. After receiving a reply, the DM-Wizard passes the full command to the RN.

Phase 2: Automate some of DM-Wizard labor (ongoing)
- Detailed analysis of Phase 1 data revealed patterns guiding development of graphical interface
- DM-Wizard communicates via the interface, which automates (and further constrains) messages

Move how far? ➔ ➤ "How far did you want me to move?"

Snippet of graphical interface for Phase 2. The DM-Wizard clicks a button and a full text message is sent to RN or Commander.

Phase 3: Automate DM-Wizard entirely (future)

Discussion & Conclusions

- Contributes to natural language & multimodal training data between humans and robots
- Identifies concepts critical to human-robot dialogue
- Extension of multi-phase development method for virtual humans and apply to embodied robots

Path Forward

- Series of studies planned that will examine:
  - Increased automation support for dialogue management
  - Multimodal inputs (head nods, eye gaze)
  - Human-robot dialogue in more complex environments