

Robotics 204: Introduction to Human-Robot Systems
Fall 2024

Lab Title: Mental Models and Hierarchical Control Levels

Submission Type: Individual submission. Each individual in your group should copy this document and record their answers. Check the [rubric](#) to make sure you have submitted all that is required.

Week 1

Part 1: Setup

Deliverable: Paste your map screenshot below

Part 2: Exploration Phase

Deliverable: Write 3 tasks that you perceive Astro can do:

Task 1:

Task 2:

Task 3:

Part 3 & 4: Evaluate your trust

Deliverable: Trust table columns fully filled out, reflection

Fill out the below trust table according to the handout. **Each individual in your group should record their trust separately.**

	No Obstacles		Obstacles 1		Obstacles 2	
Task	Performance Prediction	Performance Actual	Performance Prediction	Performance Actual	Performance Prediction	Performance Actual
Go find [person]						
Come here						
Follow me						
Go to the kitchen						
Go to charger						

Brief Reflection: Reflect on Astro’s performance as a whole. How do you think Astro would perform in a home environment based on the capabilities demonstrated during this lab?

Part 5: Data Analysis

Deliverable: Paste a screenshot of your bar chart & statistics table here:

Part 6: Reflection Questions

Deliverable: Write your answers to the below questions in the space provided.

1. Compare your initial trust in Astro to its performance in the tasks. Did Astro perform well in the tasks you thought it would? Highlight 2 tasks where Astro performed how you expected and 2 where it did not. Why do you think it may have had trouble with those tasks?
2. Think about the concept of mental models. Recall that your mental model of Astro includes information about its purpose, form, function, and behavior. Think specifically about your model of Astro's behaviors. Was this model accurate? How did you use your initial model to predict how Astro would perform in the tasks? How did your model change after you observed Astro perform the tasks?
3. Reflect on the bar chart you created. What would a bar chart for this experiment look like for a user that had calibrated trust in Astro? Does your bar chart indicate that your trust was calibrated? Why or why not? Refer to specific data from the chart to support your response.
4. In lecture, we discussed how each dimension of trust can support a user's situational awareness at every level. Think about how Astro could better support users' expectations of its behavior. Give 2 improvements that you would make. For each improvement, discuss what level of situational awareness (perception, comprehension, projection) and what dimension of trust (purpose, process, performance) it would support.
5. Consider the concept of calibrated trust. Why is it important for users to have properly calibrated trust in automated systems? Give two examples using robotic systems other than Astro that illustrate your reasoning.

Week 2

Part 7: Setup

Deliverable: No deliverables

Part 8: Controlling Astro on specified tasks

Deliverable: Trust table, discussion summary

		Factors	Levels of Control		
			Low	Mid	High
Task	Follow Me	Trust			
		Mental Demand			
		Temporal Demand			
		Frustration			
	Go To Room	Trust			
		Mental Demand			
		Temporal Demand			
		Frustration			
	Go To Charger	Trust			
		Mental Demand			
		Temporal Demand			
		Frustration			

Discussion summary: summarize what your group talked about for tasks 1, 2 & 3

Task 1

- Why did you select the ratings you did for each level of control?
- Which level of control did you prefer for this task?
- Why did you prefer the selected level of control? Consider the four rated factors in your discussion.

Task 2

- Why did you select the ratings you did for each level of control?
- Which level of control did you prefer for this task?

- F. Why did you prefer the selected level of control? Consider the four rated factors in your discussion.

Task 3

- G. Why did you select the ratings you did for each level of control?
- H. Which level of control did you prefer for this task?
- I. Why did you prefer the selected level of control? Consider the four rated factors in your discussion.

Part 9: Reflection Questions

Deliverable: Write your answers to the following questions in the space provided

1. In the second part of the lab, you had to control Astro at a low level using discrete commands to go forward, go backward, turn left, and turn right. Imagine if you had access to a joystick which could control Astro's velocity directly. How might your "frustration" and "mental demand" ratings change if low level continuous control was implemented instead of discrete control? Would you recommend designers to use continuous or discrete control for tasks 1, 2 and 3? Why? Think about the pros and cons you developed during the UI Lab earlier in the semester.
2. Think again about the low level control of Astro with discrete commands. How much movement did each command produce? Did Astro move too much or too little? What would happen to the speed and distance if the gain on the velocity were increased? What if the gain was decreased? What are the challenges if the gain for this system is set too high? Too low?
3. Reflect on each task you performed and the level of control you preferred for each task. List the level of control you preferred and why. Describe your reasons for choosing that level of control.
4. Picture Astro being used in a home environment, as if its users were the main target consumers intended by Amazon. Describe three hypothetical scenarios where each level of control would be useful to the user. Be creative in your descriptions!
5. Using your answers to questions 2 and 3, think about how levels of control are related to a robotic system's understanding of its environment. What assumptions are required for high level control to be effective? What circumstances make lower levels of control more effective? Give examples using Astro or other robotic systems.
6. Looking back to Lab 3/4 (gaze tracking), what principles from Lab 3/4 does Astro use to enhance its user experience? Which techniques work well for Astro? How could Astro improve its user experience using principles from Lab 3/4?

Grading Rubric

The following rubric will be used to grade your submission.

Week 1

Lab Part	Required Deliverables	Points
Part 1	Screenshot of map	1 pt
Part 2	Write 3 tasks astro can do	2 pt
Part 3	Raw data for the trust table has the predictions columns completed.	1.5 pts for having columns 1, 3, and 5 completed in the trust table
Part 4	Raw data for the trust table has results columns completed Reflection on Astro's performance in the lab and prediction in a home environment.	1.5 pts for having columns 2, 4, and 6 completed in the trust table 2 pts for reflection on Astro's performance in lab 2 pts for prediction on Astro's performance at home based on lab performance
Part 5	Summary data trust table is provided and formatted following TC guide best practices Bar chart is provided following TC guide best practices	2 pts: Table is clearly labeled and provides the requested averages and standard deviations, text is left-aligned, numbers are right-aligned, data is decimal-aligned 2 pts: Bar chart is clearly labeled and provides the requested averages and standard deviations
Part 6	Responses are provided for each reflection question	6 pts for 6.1: Initial trust in Astro to its performance in the tasks is discussed, using the tables and chart as a reference (1 pt). Two tasks are highlighted where it performed well (2 pt) and two tasks where it did not (2 pt). Reasoning included for why it may have struggled (1 pt). 3 pts for 6.2: Responds to mental model accuracy in context of purpose, form, and function (1 pt), how it was used to predict (1 pt), and how the model changed after observing performance (1 pt).

		<p>4 pts for 6.3: Describes bar chart when calibrated trust is present (2 pts). Interprets their bar chart in context with calibrated trust (2 pt)</p> <p>6 pts for 6.4: Two improvements are provided to support calibrated trust (3 pts each). Each improvement discusses the level of situational awareness (perception, comprehension, projection) and the dimension of trust (purpose, process, performance) it would support.</p> <p>4 pts for 6.5: Describes why calibrated trust is important (2 pt). Provides two additional examples of robotic systems where trust is important for appropriate use and how calibrated trust would manifest for that system. (1 pt for each example)</p>
	Total Points Available	37 pts

Week 2

Lab Part	Required Deliverables	Points
Part 7	No deliverable required.	0 pts
Part 8	<p>Table with survey responses is completed for the original room configuration.</p> <p>Discussion is provided on survey responses for the three tasks.</p> <p>Discussion is provided on preferred control with justification for the three tasks.</p>	<p>1 pts for completed table entries</p> <p>3 pts for discussion of survey responses</p> <p>3 pts for preferred control discussion</p>
Part 9	<p>9.1: Discussion provided on discrete vs. continuous control for low level control interactions.</p> <p>9.2: Discussion provided on Astro movement in relation to gains.</p>	<p>3 pts for discrete vs. continuous control for low level</p> <p>3 pts for discussion of movement in relation to gains</p>

	<p>9.3: Discussion of preferences across tasks and map configurations is provided.</p> <p>9.4: Discussion of three hypothetical scenarios and their level of control</p> <p>9.5: Discussion of what assumptions are required for high level controllers to be effective and what scenarios low level controllers may be effective. Specific examples are provided to support your explanation.</p> <p>9.6: Discussion of Astro's user experience focusing on concepts from Lab 3/4</p>	<p>4 pts for discussion of preferences across tasks and map configurations</p> <p>4 pts for discussion of scenarios where each with a different level of control</p> <p>3 pts for discussion of high level controller assumptions and examples</p> <p>3 pts for effective low level scenarios and examples</p> <p>3 pt for discussion of Astro's user experience</p> <p>3 pt for discussion of possible improvements</p>
	Total Points Available	33 pts