Bottle Butler 2.0

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Problem & Solution

Problem: Older adults living at an independent living facility are at increased risk for dehydration due to decreased thirst response, impaired self care capabilities, and over burdened staff.

Solution: A fully autonomous water delivery robot that performs daily rounds to deliver water to residents and performs a video recorded wellness check.

Literature Review

- Automatically delivers pills and water
- Requires care receiver to input their location

Pill & Water Delivery Robot (Victor et al., 2012)

- Controlling Multi-joint Manipulator is difficult
- Care-receiver should initiate the action

Controlling Assistive Robots with Latent Actions (Dylan et al., 2019)

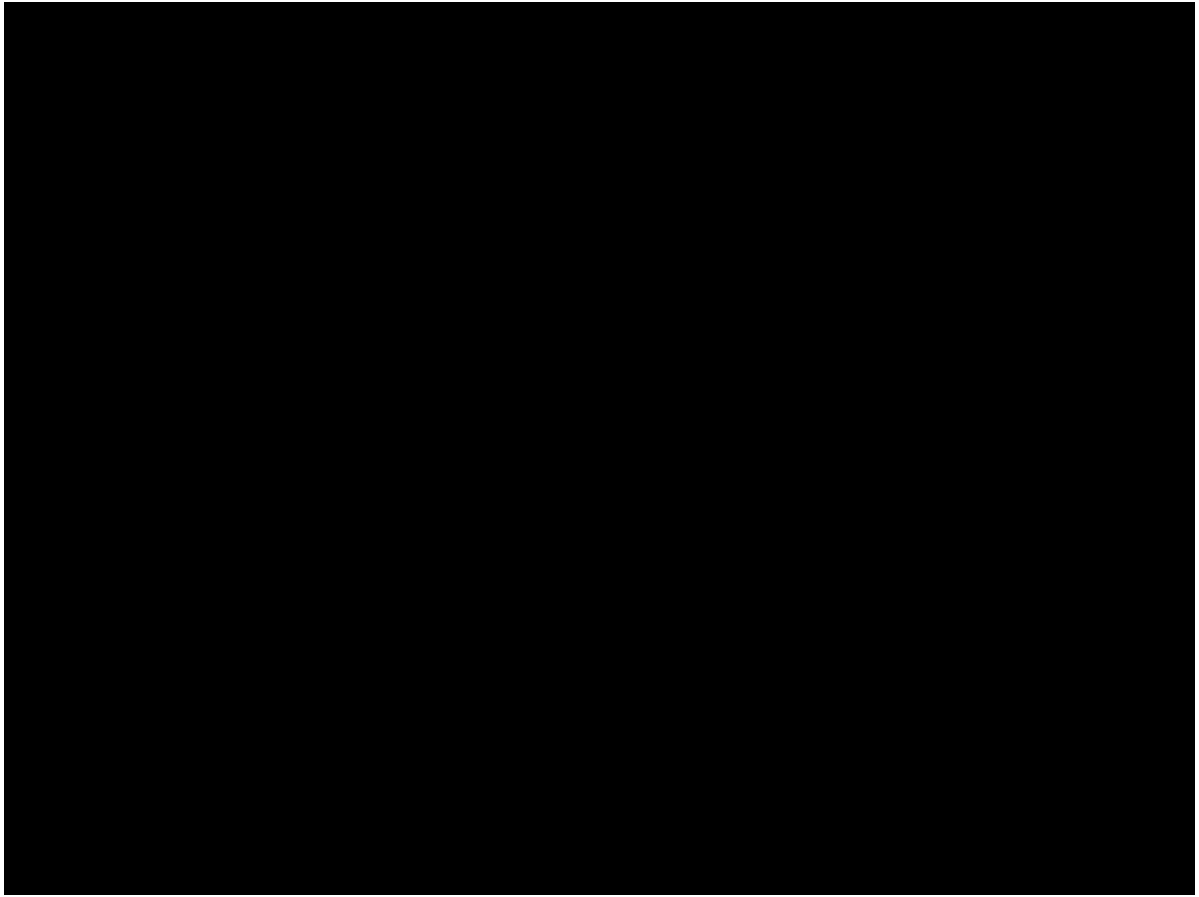
Midterm Work

Stretch opening and grabbing water from fridge

Challenges:

- Not able to open fridge robustly
- Grasping the water bottle from fridge is difficult
- Caregiver teleoperation required

Demo Video

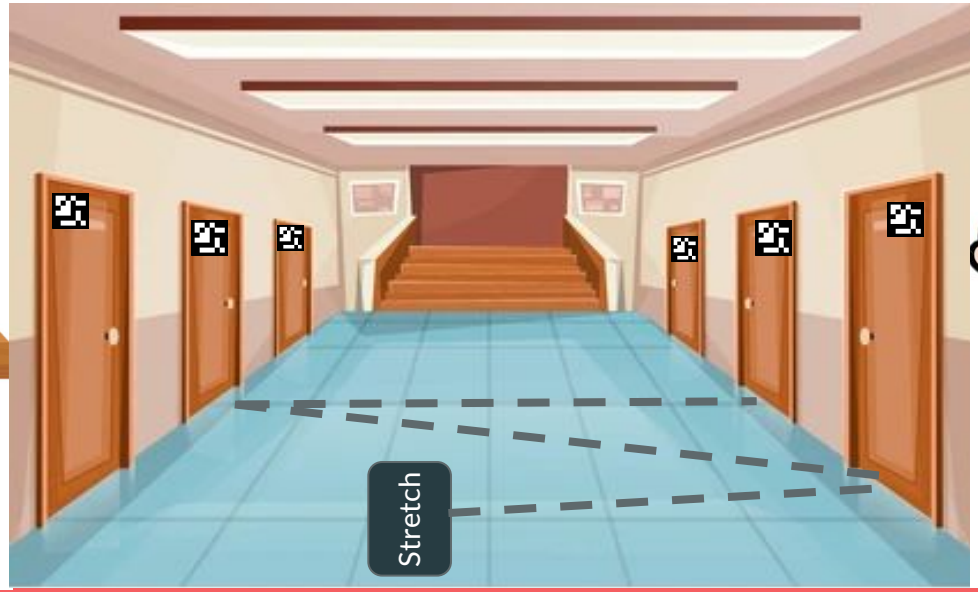


Implementation

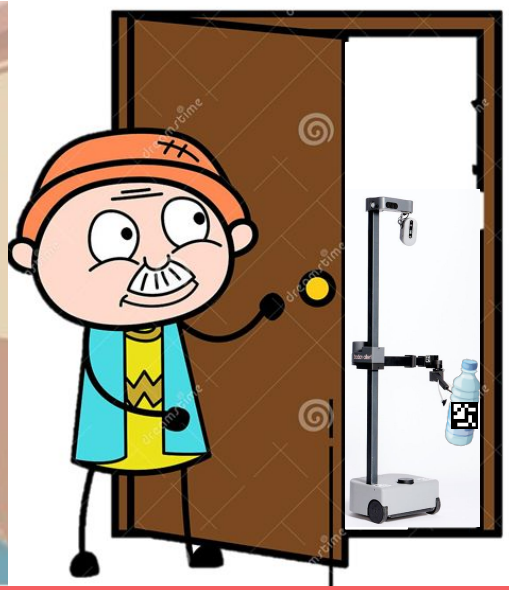
Provide hydration and wellness checks in independent living facilities.

Stretch grabs a water bottle prepared by the caregiver.

Stretch travels room to room using aruco markers.



Care receiver opens the door to get the water and Stretch records the interaction.



Interaction with Stakeholder

Talked with Arline Shea (Executive Director of large nursing facility in MA)

Independent or Assisted Living Facilities

- Full implementation in large residences will add immense value
- Can provide a simultaneous wellness check

Wellness Check

- Ensure resident is able to get up and open door
- Video reviewed by facility

Reduce Staff Burden

- Ensure consistent hydration without relying on caregivers to remember
- Free up caregivers to do other tasks

Shared Autonomy Roles

Task	Caregiver	Stretch	Care Receiver
Set up water bottles	x		
Activate Stretch upon receival of notification	x		
Find water bottles		x	
Travel to care receiver		x	
Alert care receiver of robot’s presence		x	
Take water bottle and hydrate			x
Record interaction/ perform wellness check		x	
Review video and follow up as necessary	x		

Evaluation

Category	Metric	Value
Scanning aruco markers	Table success rate	96%
	Door success rate	92%
	Bottle success rate	84%
Accuracy moving to table	X-direction offset	+/- 3 cm
	Y-direction offset	+/- 5 cm
	Angle offset	+/- 7 degrees
Accuracy grasping bottle	Success rate	74%
Accuracy moving to door	X-direction offset [cm]	+/- 9 cm
	Y-direction offset [cm]	+/- 12 cm
	Angle offset [degrees]	+/- 13 degrees

Discussion & Challenges

- Lighting variations
  - If lighting is not optimal, it may not see the aruco on the water bottle
- Aruco inaccuracies
  - Requires variable offsets to improve accuracy
- Only carries 1 bottle at a time
  - Wastes time moving back and forth between doors and table
- Robot doesn’t detect when care receiver takes the bottle

Future Work

- Utilize ROS mapping system instead of Aruco markers
- Implement robot to start at set times automatically
- Develop basket-like effector
- Provide fridge option
- Implement controls systems to improve accuracy
- Detection of handoff using force sensors

References

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  - https://pubmed.ncbi.nlm.nih.gov/10522951/
  - https://www.mcgill.ca/familymed/files/familymed/effective_hydration_in_elderly.pdf
- Meeting with Ethan Wang (Miles' friend)
- Meeting with Arline Shea (Nursing Home Manager)
- Remote teleoperation by Travis Kadylak
- Aruco Marker Navigation
  - http://wiki.ros.org/aruco_detect
- Robot used for pill & water delivery
  - https://smartech.gatech.edu/bitstream/handle/1853/45009/MedicationDeliveryTechReport.pdf?sequence=1&isAllowed=y
- Controlling Assistive Robots with Latent Actions (Dylan et al., 2019)
  - https://iliad.stanford.edu/blog/2019/11/12/controlling-assistive-robots-with-learned-latent-actions

Thank You

Questions or Comments?