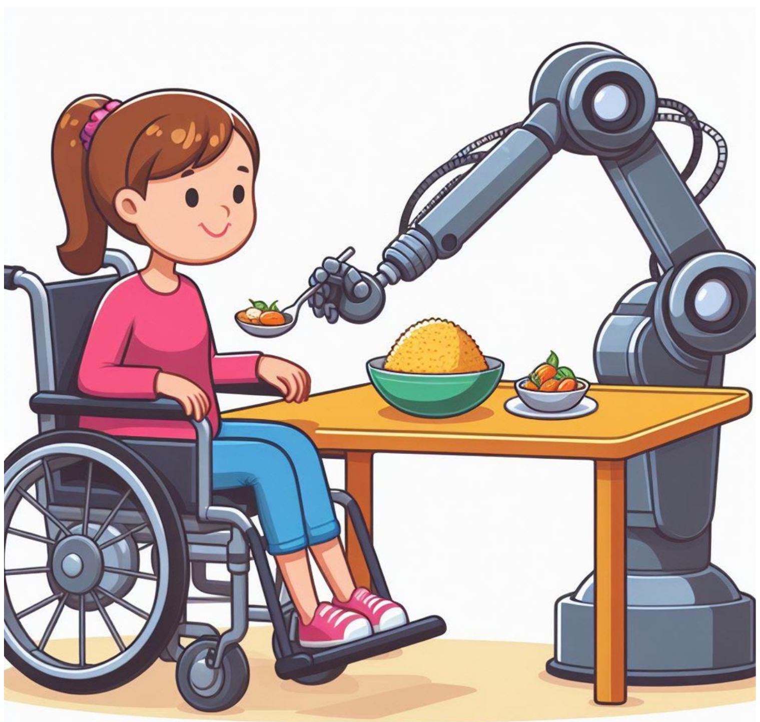
Towards In-Home Deployments of Physically Assistive Robots: Insights from Robot-Assisted Feeding for People with Motor Impairments



Amal Nanavati

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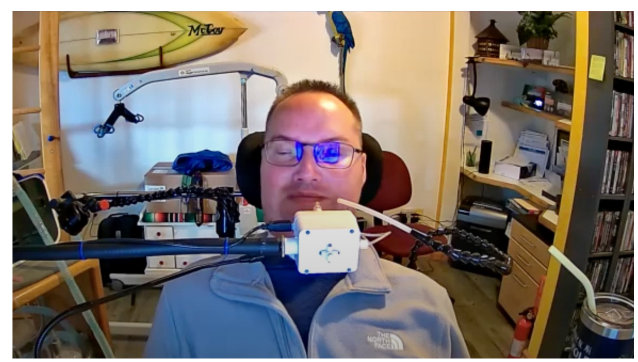
2025-01-24

UNIVERSITY of WASHINGTON

Think about a recent **enjoyable meal** experience.

What made it **meaningful**?

"Sometimes I wait little longer to ask [my caregiver] for a bite or a drink because it might mess up a conversation. It's definitely something that's always in the back of my mind while eating socially… Sometimes I find that I'm not eating or barely eating at all because I'm a little self-conscious of interrupting a conversation." (P2)

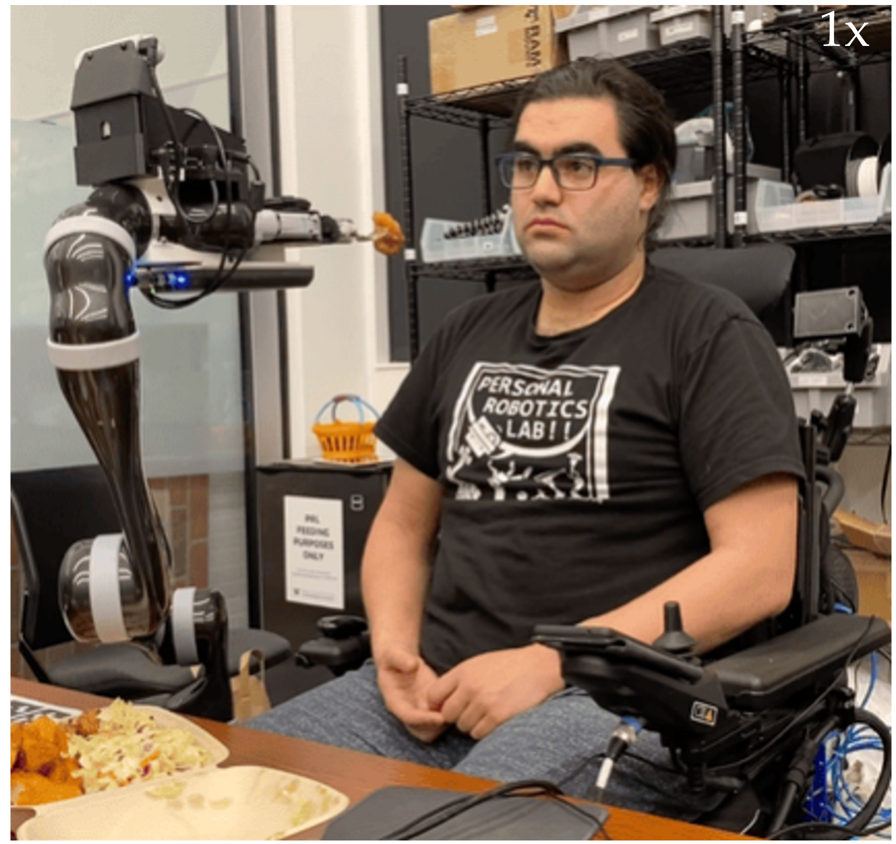


1.8 million Americans need assistance eating*

* as of 2010

Theis, Kristina A., et al. "Which one? What kind? How many? Types, causes, and prevalence of disability among US adults." *Disability and health journal*. (2019)

Deployable Robot-assisted Feeding (RAF)



generalize across users

usable without researcher intervention

generalize across environments

How can we develop a deployable robot-assisted feeding system that enables any* user, in any* environment, to feed themselves a meal of their choice†, while aligning with their preferences?

customizable

generalize across foods

* "any" = North Star.
Demonstrate it with "multiple"

† that can be acquired with a single arm using a fork

Roadmap

1. Motivation
2. Robot-Assisted Feeding Overview
3. RQ1: Users’ Needs Assessment
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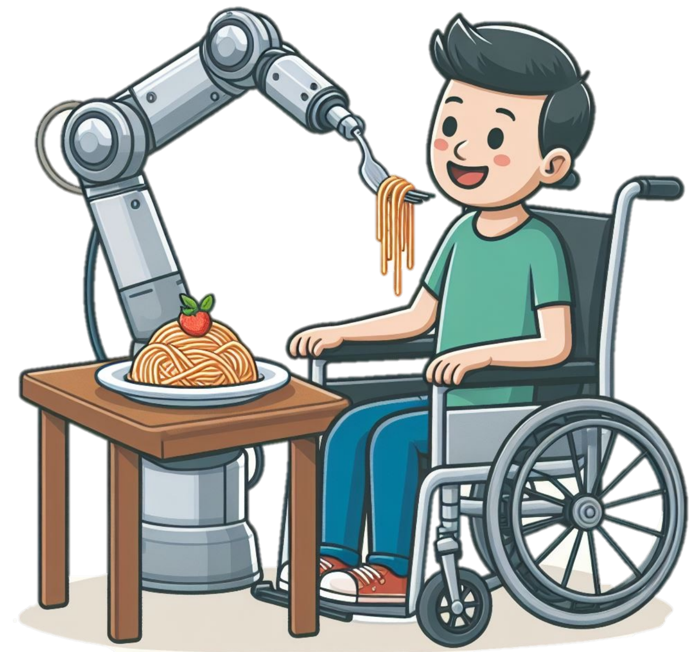
5. RQ3: Developing a Deployable System
6. Evaluations & Lessons Learned

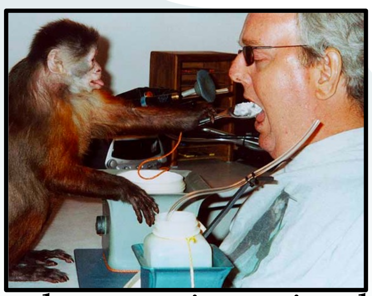


Self-feeding has been a research goal since the 1970s

Commercial

1970s	1980s	1990s	2000s	2010s	2020s

Research



monkey service animals, 1977

Hien, Emmanuelle, and Bertrand L. Deputte. "Influence of a capuchin monkey companion on the social life of a person with quadriplegia: an experimental study." *Anthrozoös*. (1997)

Envisioning Access: Our Past

Self-feeding has been a research goal since the 1970s

Commercial

1970s	1980s	1990s	2000s	2010s	2020s

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Morewood Spoon Lifter, 1974

monkey service animals, 1977

Philips, G. N. “Feasibility Study for Assistive Feeder”. *Southwest Research Institute*. (1986)

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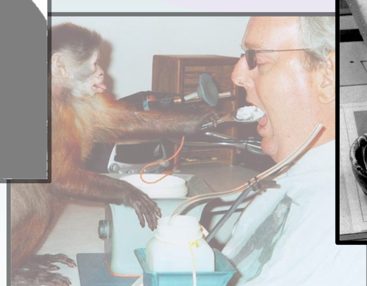
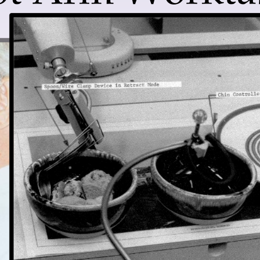
Morewood Spoon Lifter, 1974



monkey service animals, 1977

Robot Arm Worktable, 1986



Handy 1, 1987

Seamone, W., and G. Schmeisser. "Early clinical evaluation of a robot arm/worktable system for spinal-cord-injured persons." *Journal of rehabilitation research and development* (1985)

Topping, Mike. "An overview of the development of Handy 1, a rehabilitation robot to assist the severely disabled." *Artificial Life and Robotics* (2000)

1970s-80s: Deployments & Clinical Evaluations

The staff reported that most individuals who were shown the original spoon lifter were negative towards gadgets and preferred to have someone feed them. However, one C_4 level quadriplegic subject was able to functionally feed himself a complete meal using the device. This subject requested permission to take the device home, and arrangements were made for him to do so. He continued to use it in the home situation for almost three years. This individual found it necessary to put Reston Foam under the front of the head band to relieve the pressure against his forehead and to help to keep the head band from slipping. The staff at this center made the initial suggestions that were incorporated in the modified feeder, and this subject's spoon lifter was modified. The staff also reported that the subject had to have good trunk balance in order to use the feeder and that the motor would stall if food was stuck to the bottom of the spoon.

Progress—Through December 1984, 20 male quadriplegics between 21 and 60 years of age at evaluation had been involved in the evaluation in three geographical areas, i.e., Baltimore-Washington, Richmond, and Cleveland. They ranged from five to 26 years between time of injury and evaluation. The levels of injury ranged from C-2 to C-5. Individual accumulations of time actually working with the equipment ranged from one hour to over 100 hours; 316 meals were eaten by these individuals using the Robot Arm. Among the nine quadriplegics who tested the equipment at the Richmond VAMC, seven indicated that they found the equipment gratifying to use, especially for self-feeding. Among the seven

Robot Arm Worktable (1980s):

- 20 people with quadriplegia
- Environments: family home, nursing home, hospital

Morewood Spoon Lifter (1970s):

- 16 veterans with spinal cord injuries
- 3 year home deployment

Seamone, W., and G. Schmeisser. "Early clinical evaluation of a robot arm/worktable system for spinal-cord-injured persons." *Journal of rehabilitation research and development* (1985)

Philips, G. N. "Feasibility Study for Assistive Feeder". *Southwest Research Institute*. (1986)

Commercial translation in 1990s-2000s

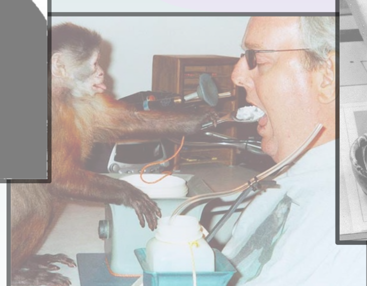
Commercial

Winsford Feeder, 1990s

1970s	1980s	1990s	2000s	2010s	2020s

Research

Morewood Spoon Lifter, 1974



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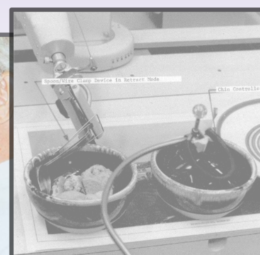
Robot Arm Worktable, 1986

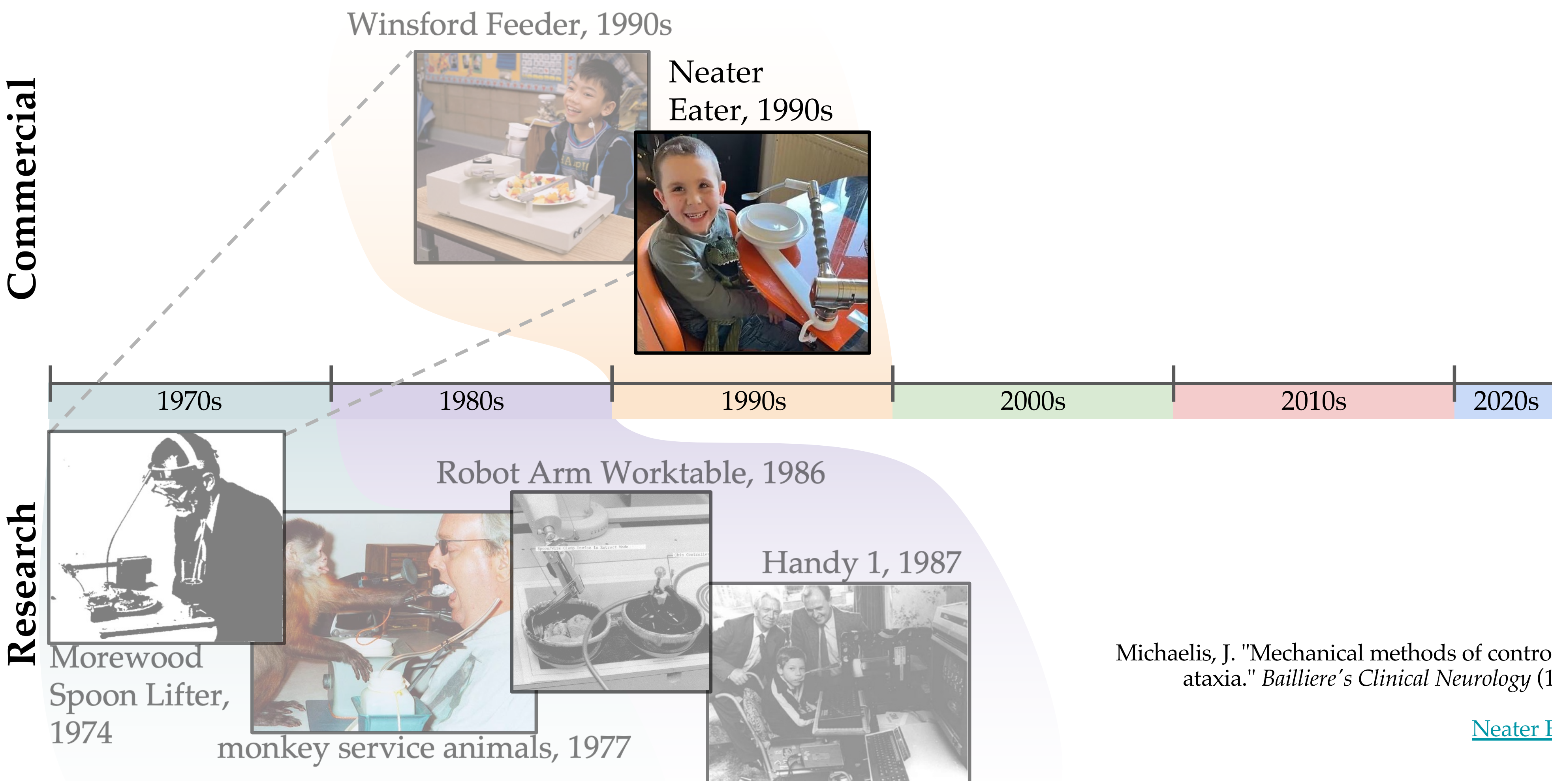


Handy 1, 1987

Harwin, William S., Tariq Rahman, and Richard A. Foulds. "A review of design issues in rehabilitation robotics with reference to North American research." *IEEE Transactions on Rehabilitation Engineering* (1995)

Winsford Feeder Brochure (2011)

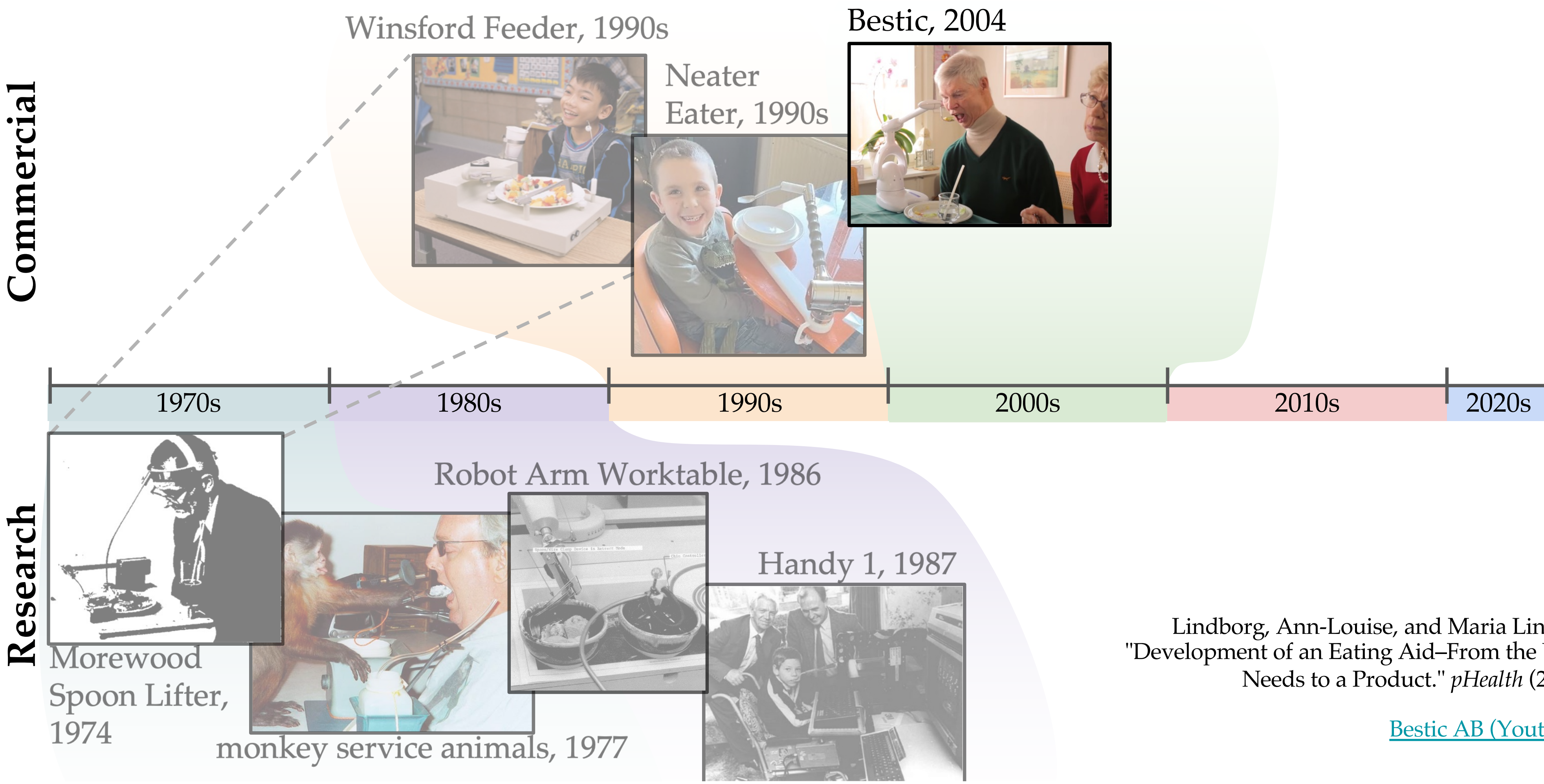
Commercial translation in 1990s-2000s



Michaelis, J. "Mechanical methods of controlling ataxia." *Bailliere's Clinical Neurology* (1993)

Neater Eater

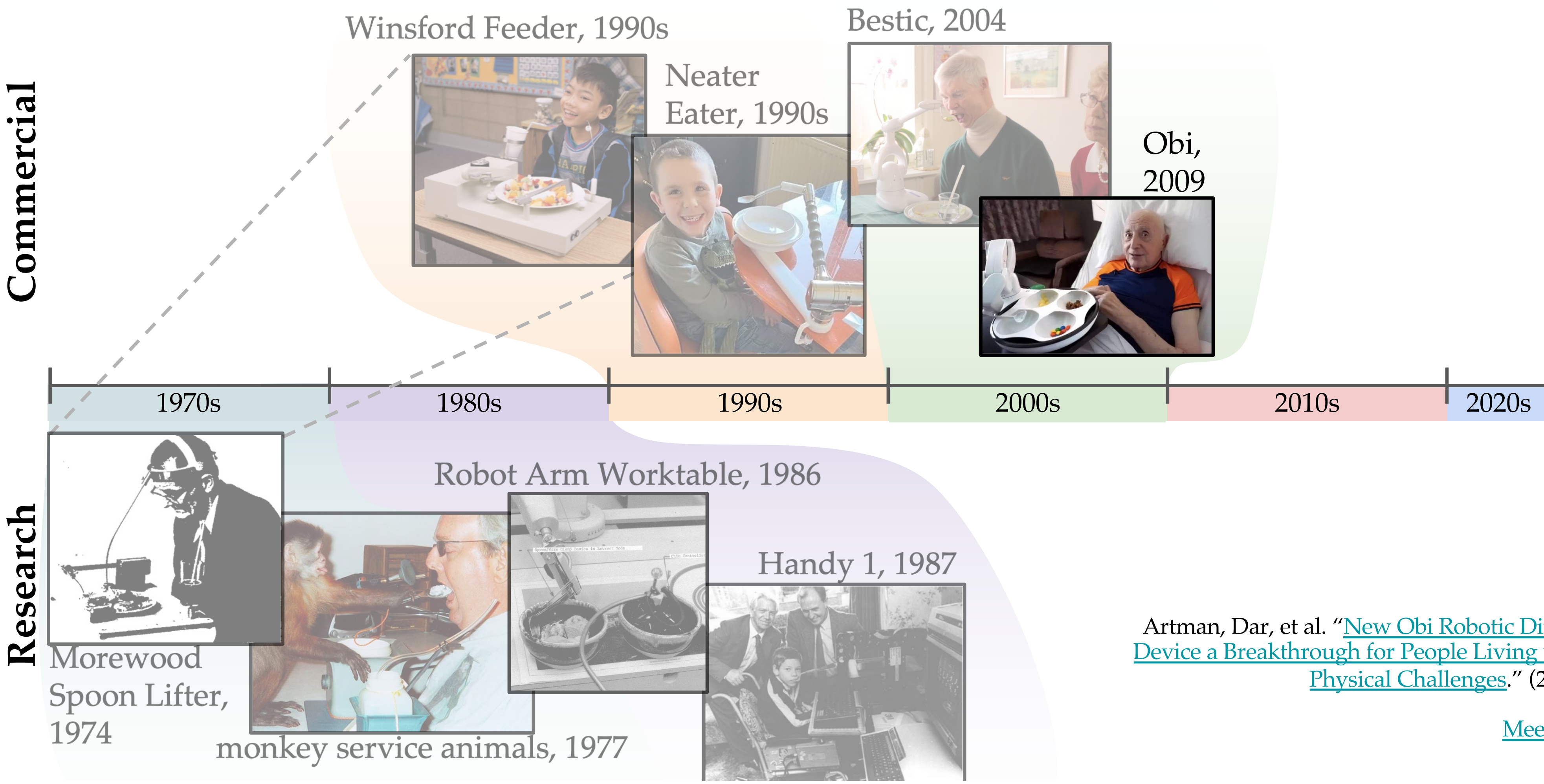
Commercial translation in 1990s-2000s



Lindborg, Ann-Louise, and Maria Lindén. "Development of an Eating Aid–From the User Needs to a Product." *pHealth* (2015)

Bestic AB (Youtube)

Commercial translation in 1990s-2000s



Artman, Dar, et al. "New Obi Robotic Dining Device a Breakthrough for People Living with Physical Challenges." (2016)

MeetObi

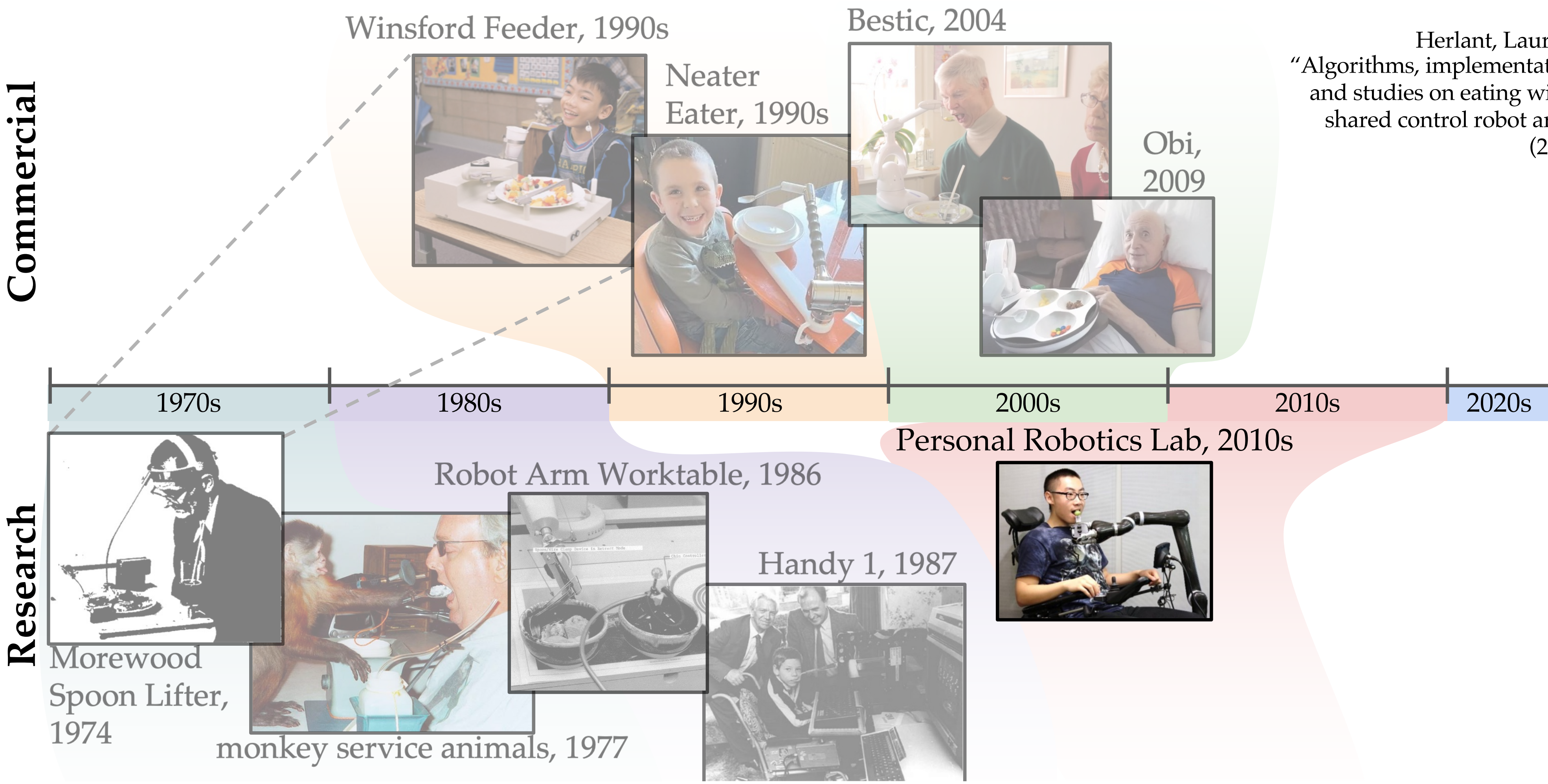
1990s-2000s: Is Robot-Assisted Feeding Solved?

- Strengths of Commercial Systems*:
  - Independently eating a full meal
  - Increased feelings of confidence
  - Improved posture
- Shortcomings of Commercial Systems*:
  - Only able to acquire limited foods
  - Acquiring too little food
  - Dropping food
  - Requiring users to hold head in stationary position

MeetObi

* citations in dissertation

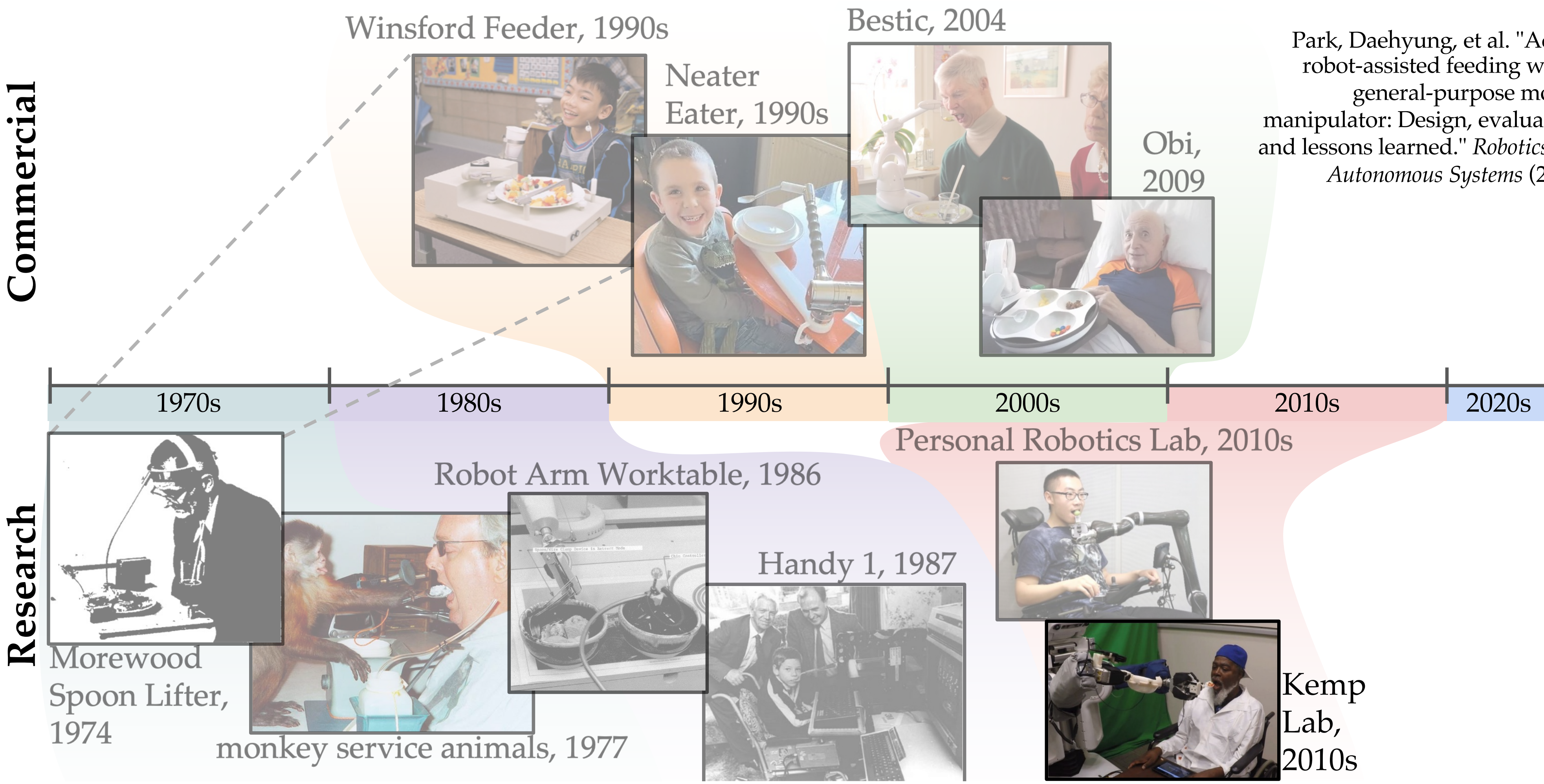
Modern Robot-assisted Feeding Research, 2010s-



Herlant, Laura V. "Algorithms, implementation, and studies on eating with a shared control robot arm". (2016)

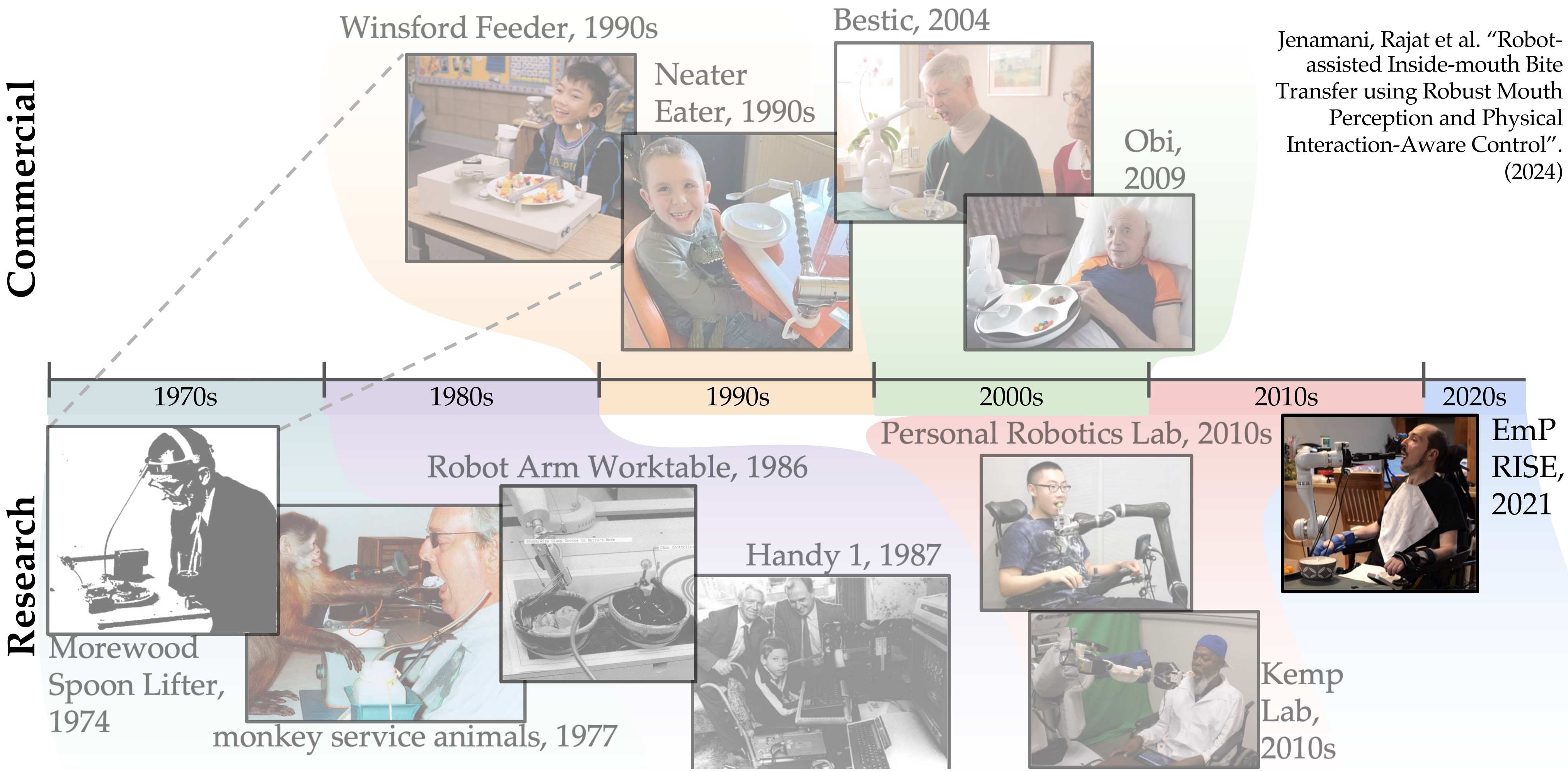
Modern Robot-assisted Feeding Research, 2010s-

Park, Daehyung, et al. "Active robot-assisted feeding with a general-purpose mobile manipulator: Design, evaluation, and lessons learned." *Robotics and Autonomous Systems* (2020)



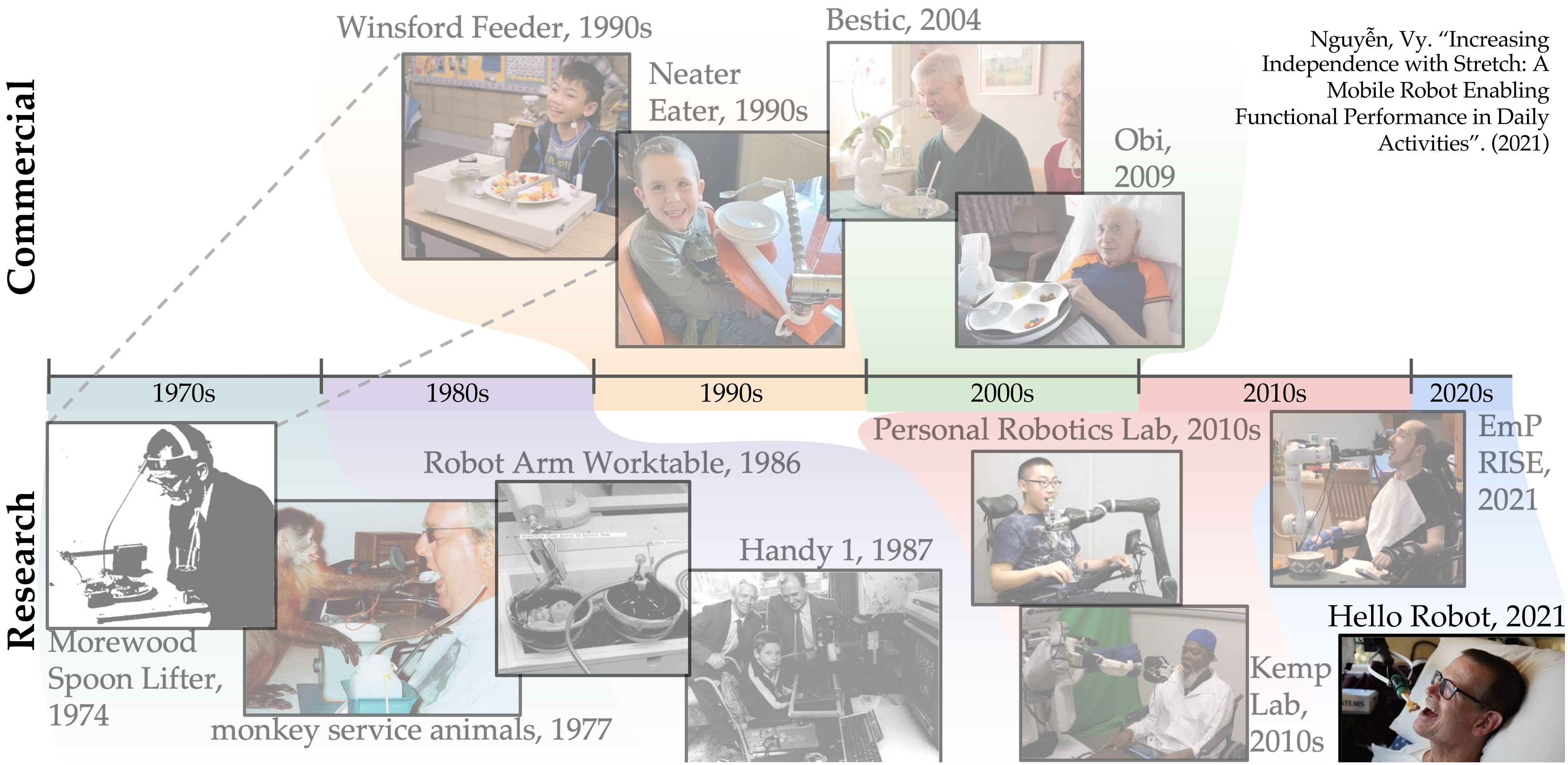
Modern Robot-assisted Feeding Research, 2010s-

Jenamani, Rajat et al. "Robot-assisted Inside-mouth Bite Transfer using Robust Mouth Perception and Physical Interaction-Aware Control". (2024)



Modern Robot-assisted Feeding Research, 2010s-

Nguyễn, Vy. "Increasing Independence with Stretch: A Mobile Robot Enabling Functional Performance in Daily Activities". (2021)



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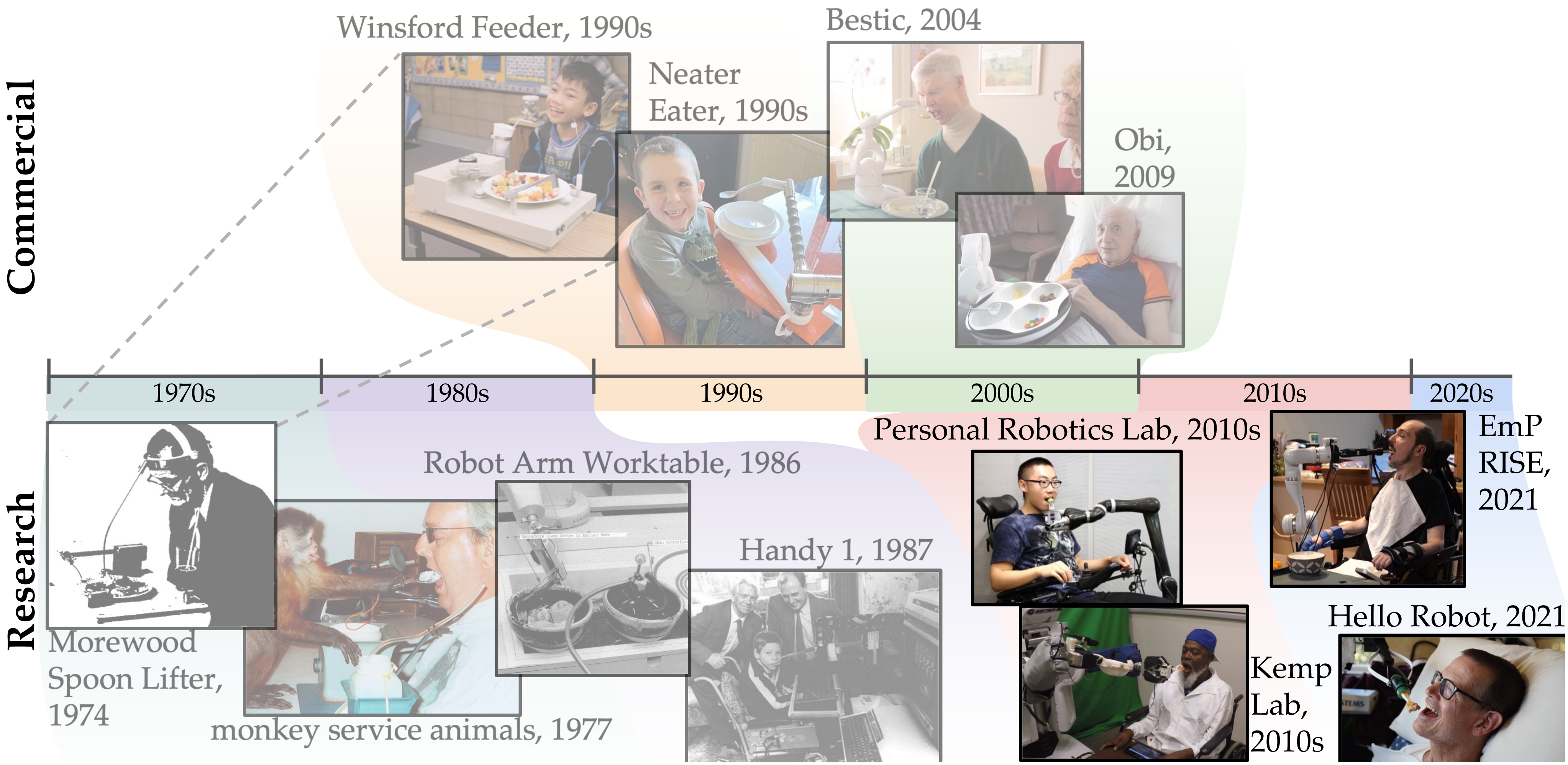
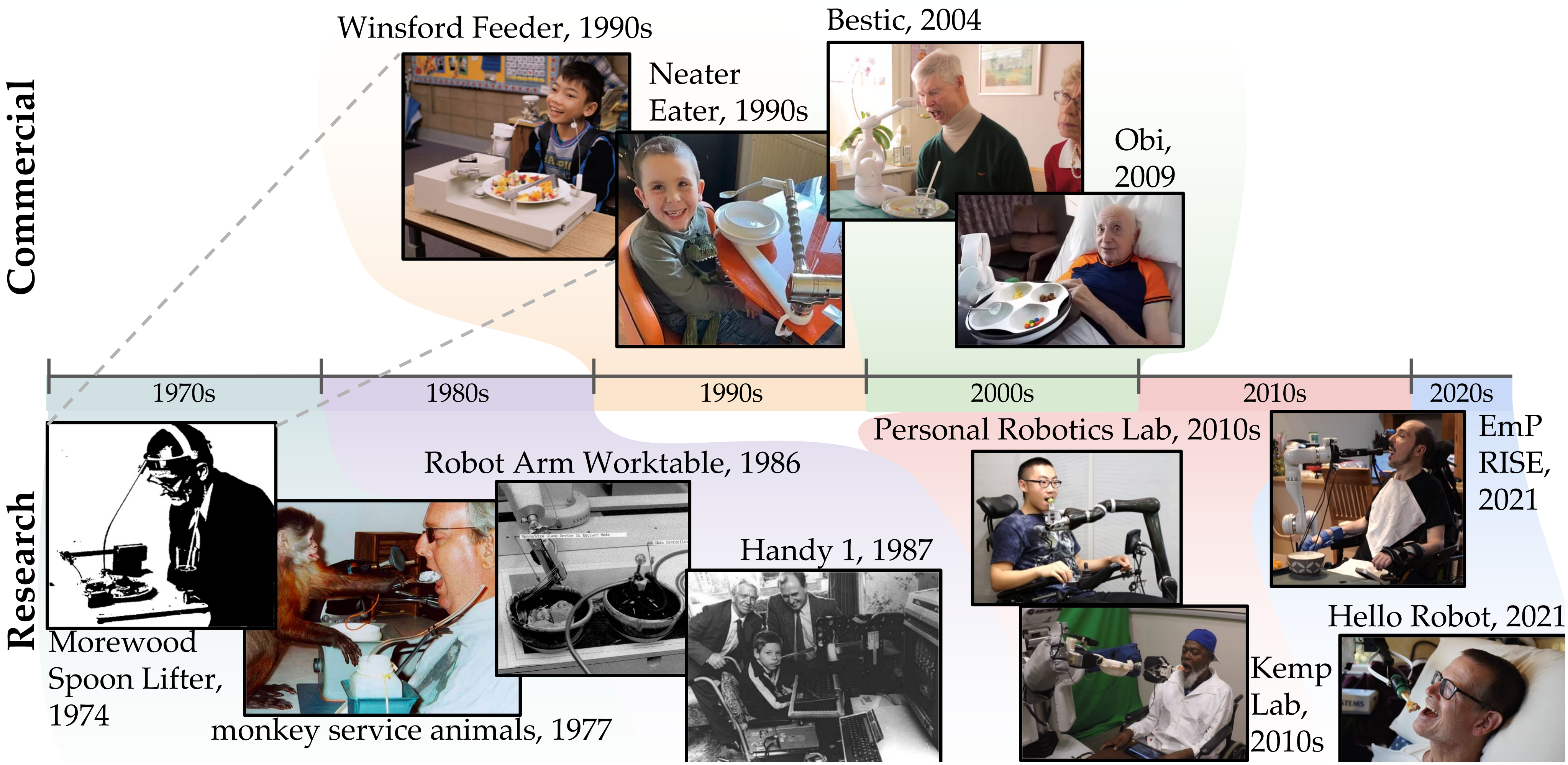


Modern Robot-assisted Feeding Research, 2010s-



Our Robot-assisted Feeding System

Bite Acquisition

Bite Transfer

Community-Based Participatory Research (CBPR)

Tyler Schrenk

- Entire research process is grounded in and accountable to community needs and priorities
- **Community Researchers (CRs)**: equal team members throughout the process, from ideation to dissemination
- Academic & community researchers each bring unique skills, expertise, and **lived experience** to the table
- Learn from each other
- Long-term partnership

Israel, B. A., Schulz, A. J., Parker, E. A., & Becker, A. B. "Review of community-based research: assessing partnership approaches to improve public health". *Annual review of public health*. (1998)

Jonathan Ko

Roadmap

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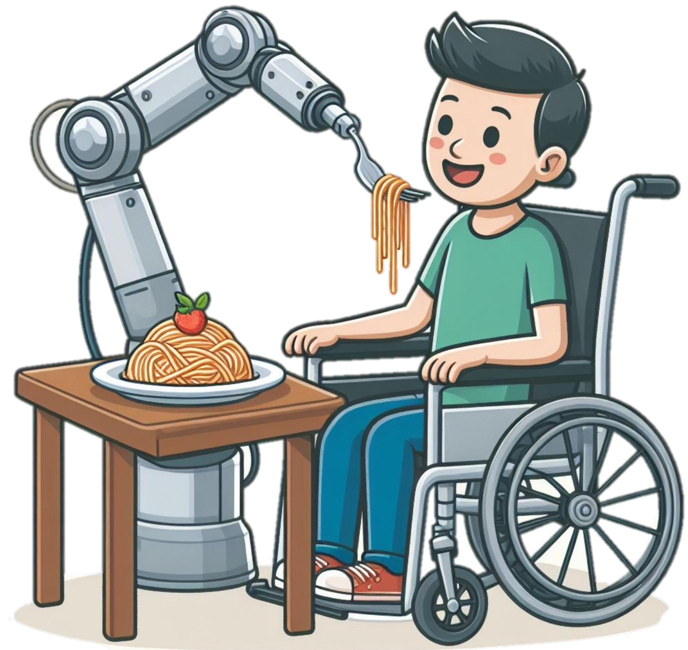


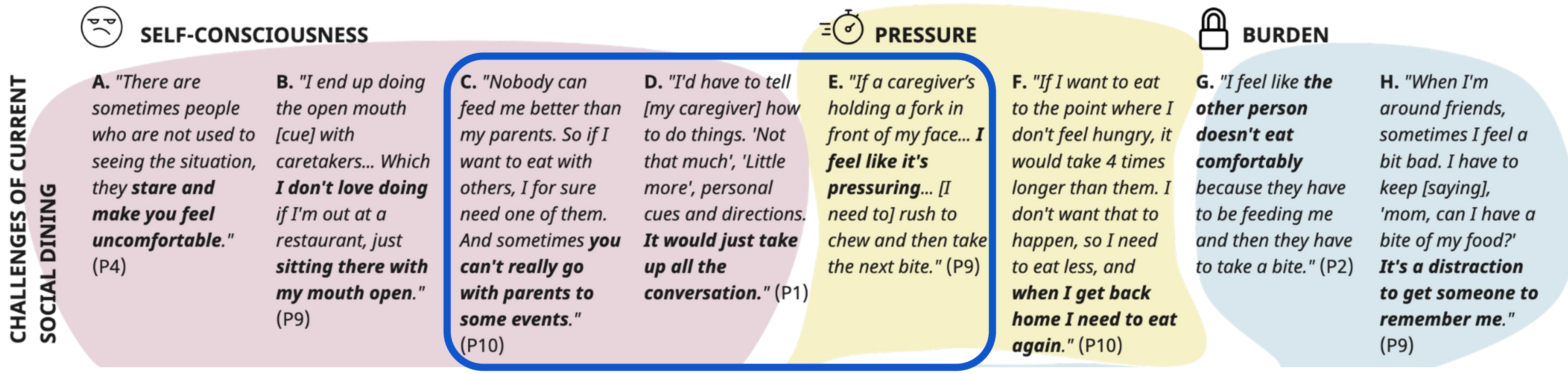
RQ1: What challenges do users face during dining, and how can a robot-assisted feeding system address them?

Nanavati, Amal*, Patrícia Alves-Oliveira*, et al. "Design principles for robot-assisted feeding in social contexts." *HRI*. (2023)
Best Design Paper Award 🥇

Method

- Remote, semi-structured interviews led by community researcher
- n=10 participants
- Study stages:
  - Discuss current dining routines
  - Watch social dining videos showcasing various robot features
  - Discuss participants' thoughts
- Thematically analyzed participant quotes

[redacted]



Caregiver Variability

Caregivers feed differently (e.g., bite size, eating pace, etc.)

Participants feel self-conscious about interrupting a conversation to instruct their caregiver

Participants don't feel comfortable bringing some caregivers to some social interactions.

Participants want **consistent customization**

Design Principles

CUSTOMIZATION
The robot should be adaptable to contexts and user needs.

INCLUSIVITY
The robot should accommodate a user's impairments.

CONTROL
The robot should defer high-level decision making to the user.

MINIMALISM
The robot should be compact and part of the user's assistive tech ecosystem.

SUBTLETY
The robot should be discrete and unnoticeable.

RELIABILITY
The robot should be consistent and error-free.

INTEGRATION
The robot should integrate meal tasks beyond feeding.

INTERACTIVITY
The robot should be able to interact with others.

Nanavati, Amal*, Patrícia Alves-Oliveira*, et al. "Design principles for robot-assisted feeding in social contexts." *HRI*. (2023)

Design Principles: **Reliability**

A.

“If it can't get it on the first try, it’s still on the plate, **[the food’s] not on me**. If it drops it on the way that would be worse.” (P1)

B.

“If it was at a soccer game where [my wife] was sitting next to me, the side-resting position could **be in her way, in front of her face**.” (P8)

C.

“I want everyone to just see me, not **see me behind a feeding device**.” (P9)

RELIABILITY

The robot should be consistent and error-free.

Design Principles: **Control**

D.

"When it's something as delicate as 'if this messes up I can get impaled,' it would be good to have a **backup safety mechanism**." (P8)

E.

"I'm not too fond of [automatic bite initiation]. It's restrictive. By **giving the robot the command**, you are controlling the robot." (P6)

F.

"For me, I don't mind the robot doing a lot of the thinking, with the exception of **selecting what food I eat**." (CR)

CONTROL

The robot should defer high-level decision making to the user.

Design Principles: **Customizability**

G.

“In a perfect world, I'd be able to choose **how much food it gives to me** [in a bite]. Choking is a huge hazard.” (P8)

H.

“**If the table is noisy**, then [I’d use] mouth open. **If it's not too noisy**, then [I’d use] verbal.” (P6)

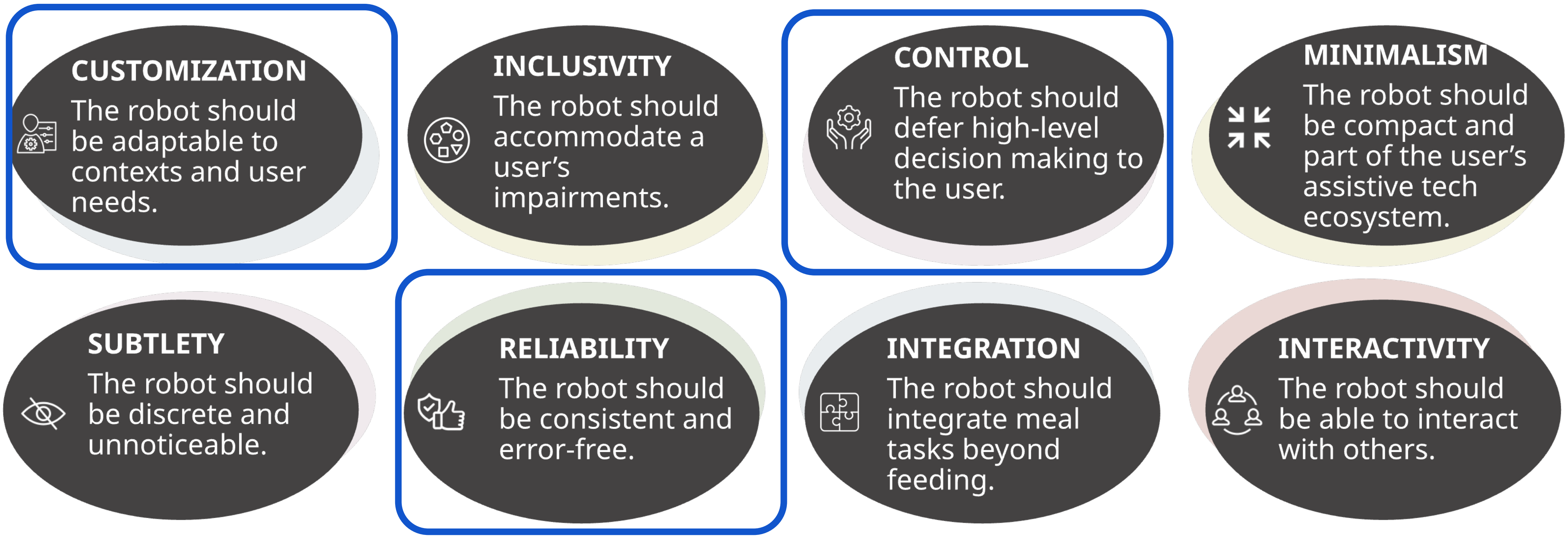
I.

“Every person is different. **The way we sit, the way we eat**, we have our own positions and height. This robot, they'd have to customize it.” (P3)

CUSTOMIZATION

The robot should be adaptable to contexts and user needs.

Design Principles



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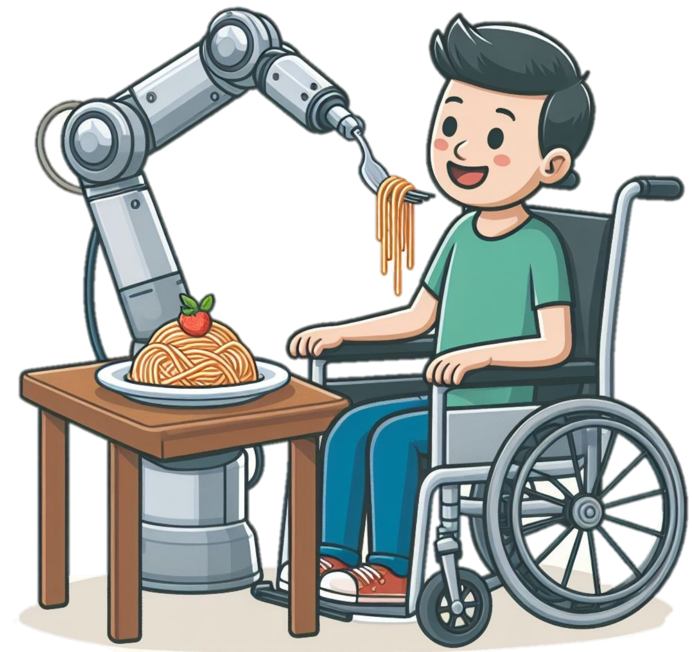
Roadmap



generalize across users

usable without researcher intervention

generalize across environments

How can we develop a deployable robot-assisted feeding system that enables any* user, in any* environment, to feed themselves a **meal of their choice†**, while aligning with their preferences?

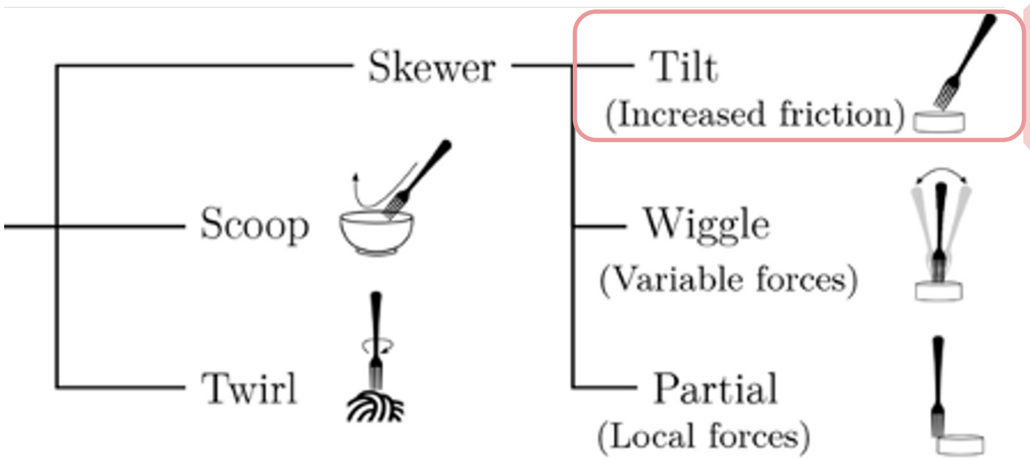
customized

generalize across foods

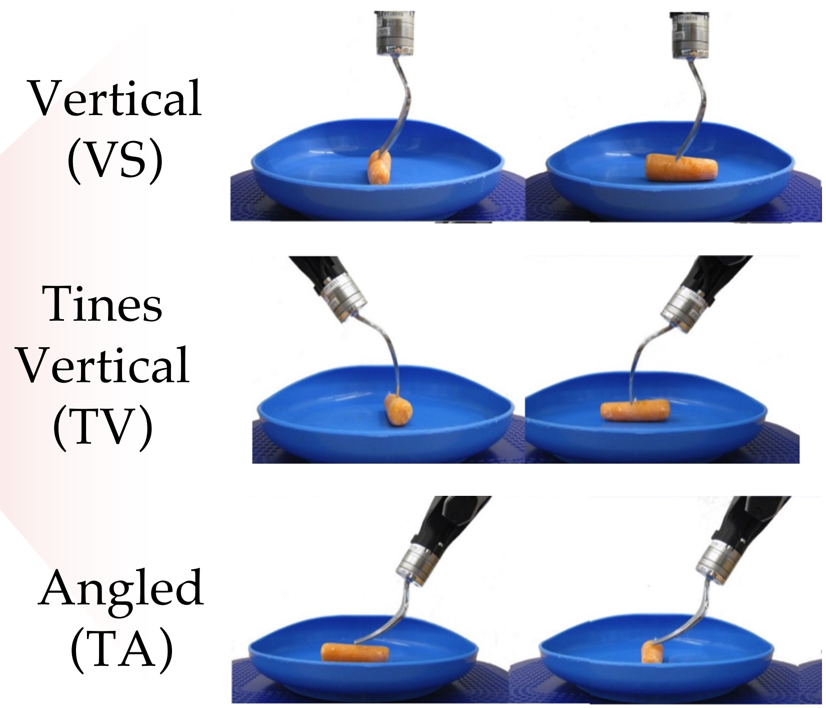
RQ2: How can a robot-assisted feeding system reliably acquire the large variety of food items users may want to eat?

Gordon, Ethan K*, **Nanavati, Amal***, et al. "Towards General Single-Utensil Food Acquisition with Human-Informed Actions." *CoRL*. (2023)

Bite Acquisition: Past Work

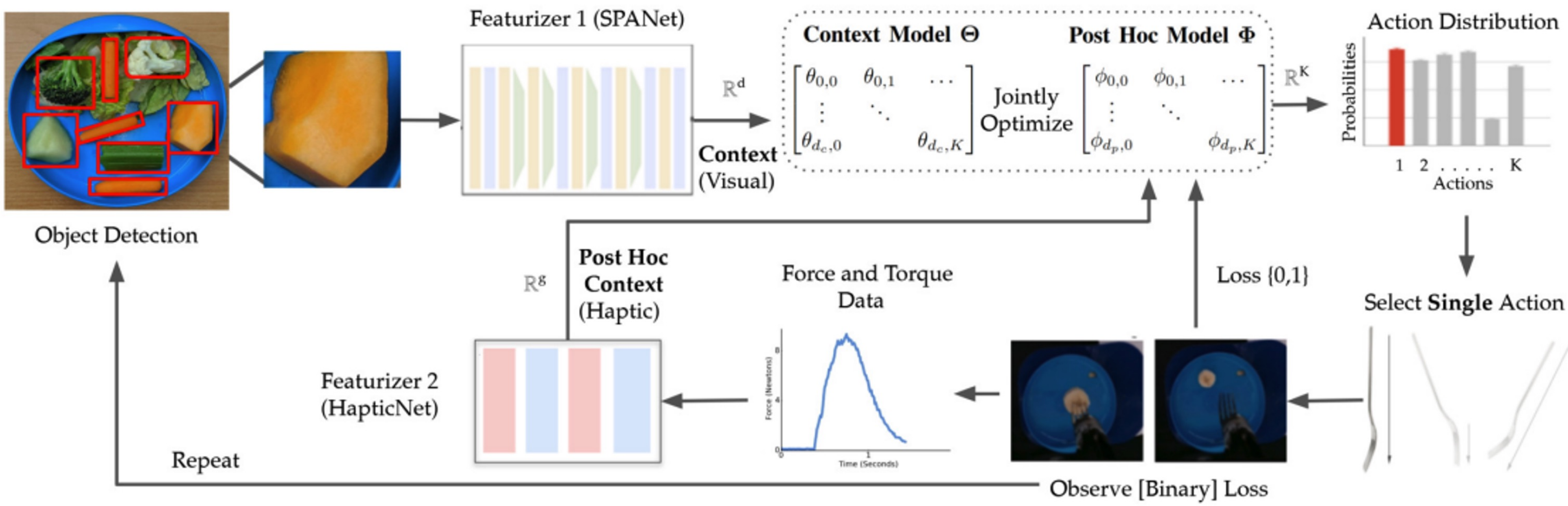


Bhattacharjee, Tapomayukh, et al. "Towards robotic feeding: Role of haptics in fork-based food manipulation." *IEEE Robotics and Automation Letters* (2019)



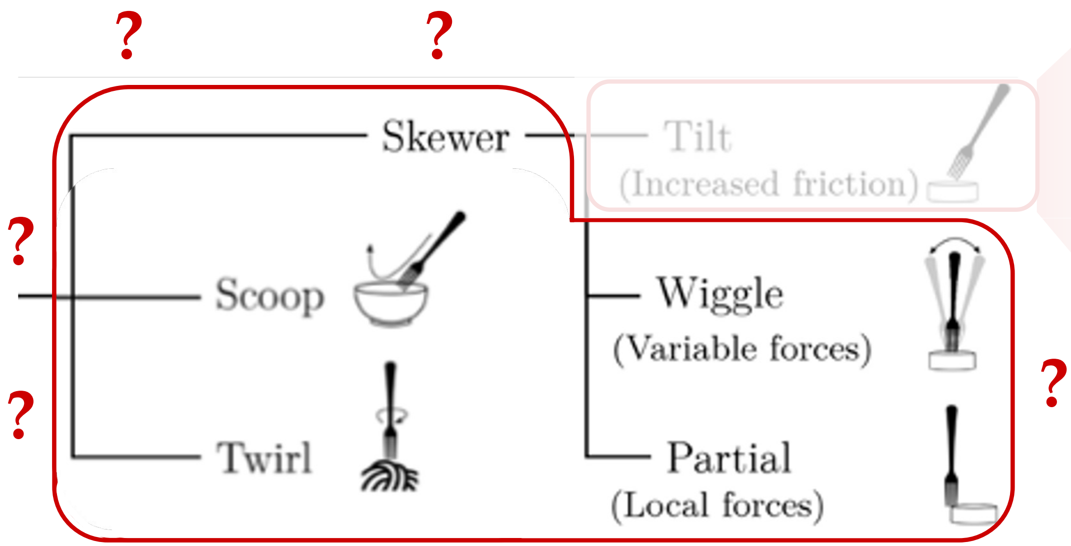
Feng, Ryan, et al. "Robot-assisted feeding: Generalizing skewering strategies across food items on a plate." *The International Symposium of Robotics Research*. (2019)

Bite Acquisition: Past Work



Gordon, Ethan K., et al. "Leveraging post hoc context for faster learning in bandit settings with applications in robot-assisted feeding." *IEEE International Conference on Robotics and Automation (ICRA)*. (2021)

Bite Acquisition: Past Work



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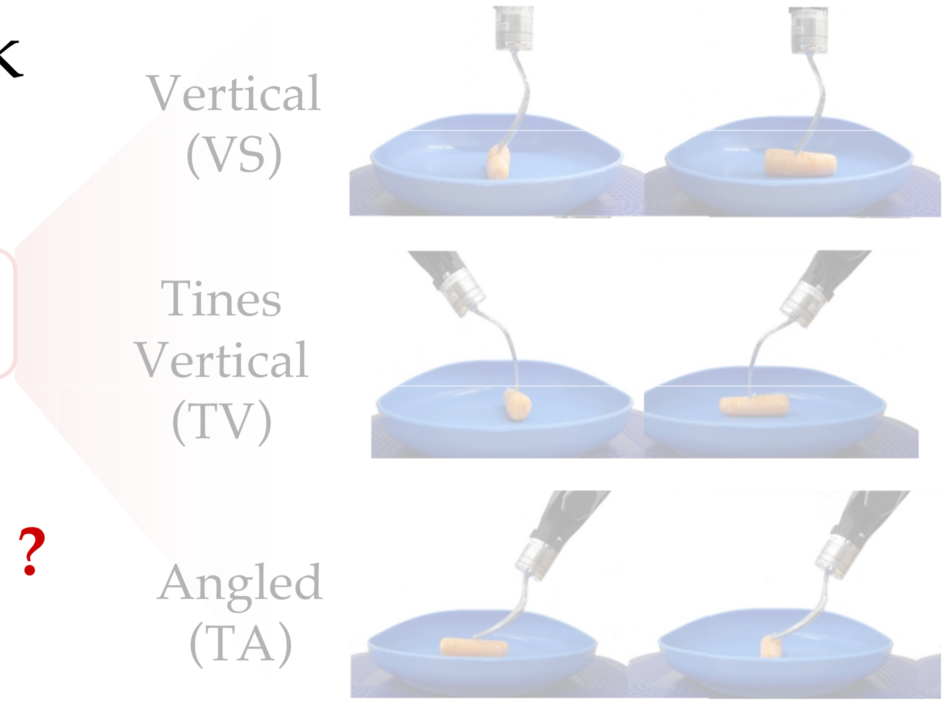

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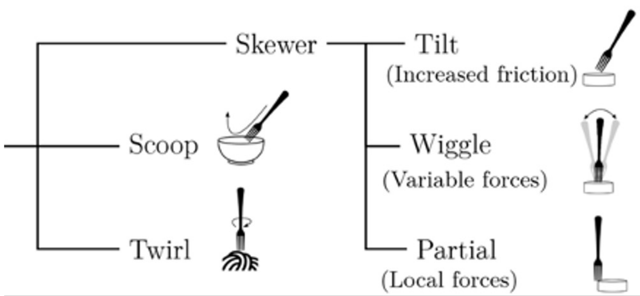
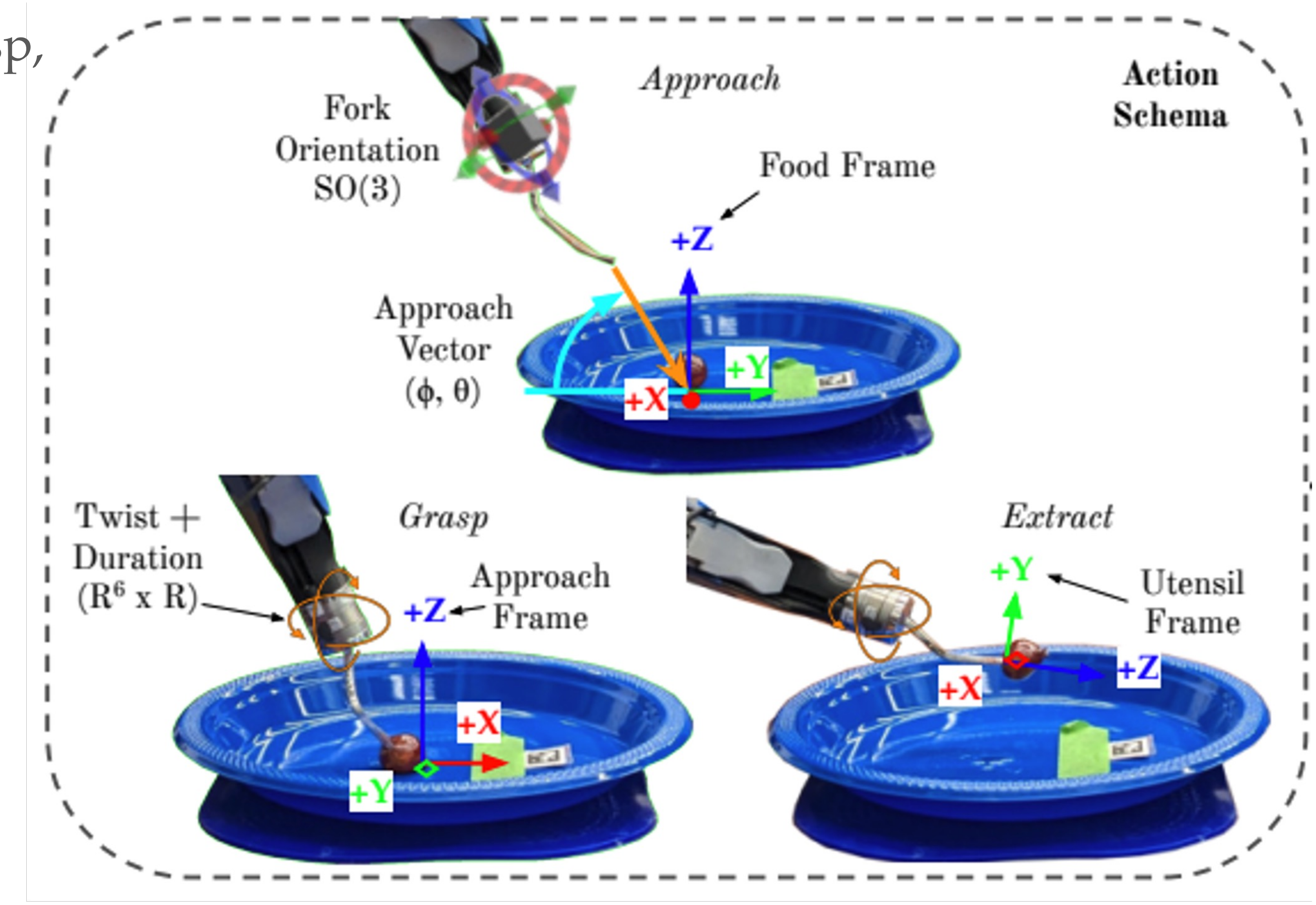
Key Insight: Bite Acquisition Actions are Structured

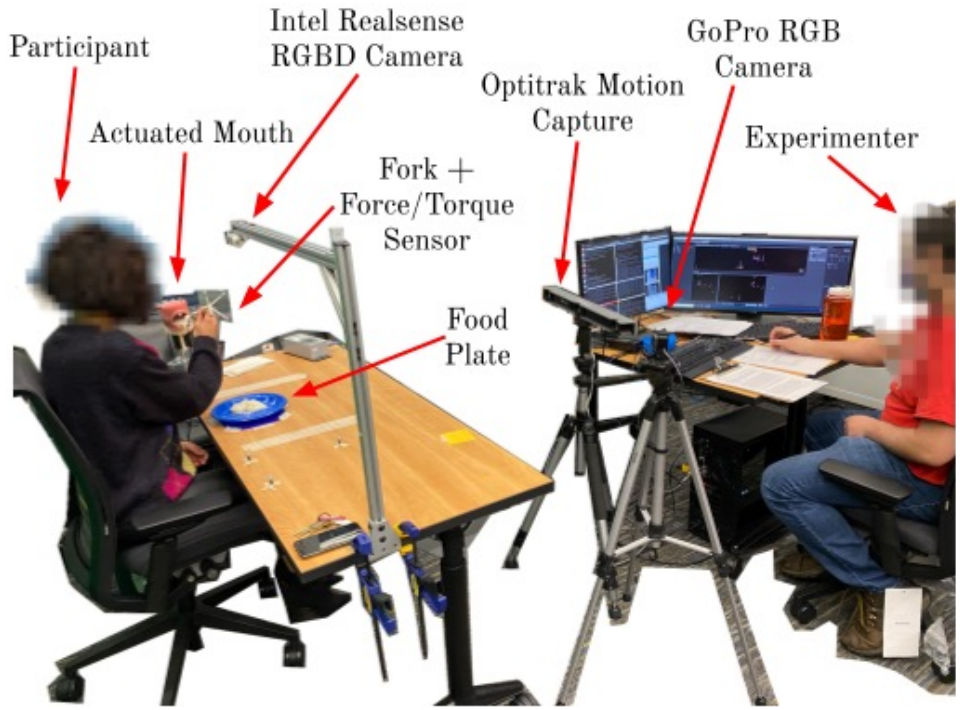
- 3 steps: Approach, Grasp, Extract
- **Action Schema**: 26 continuous parameters
- Encompasses entire taxonomy





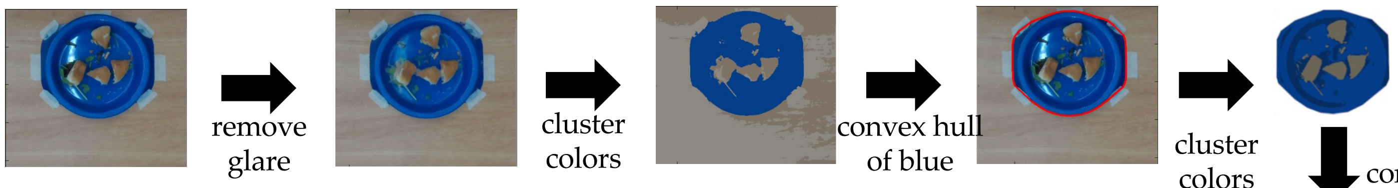
What actions within this schema do humans use?

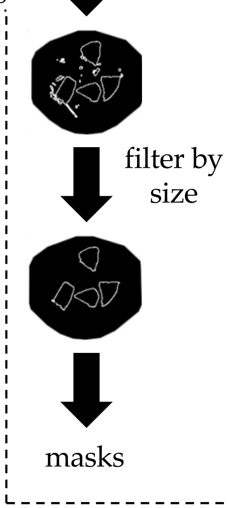
- 9 participants
- 13 foods
  - e.g., sandwich bites, pizza, chicken tenders, noodles, rice & beans, etc.
- Data:
  - Fork motion (SE(3) over time)
  - Fork forces & torques
  - Food RGB-D data
- ~9 hours, 500+ trajectories
  - open-sourced

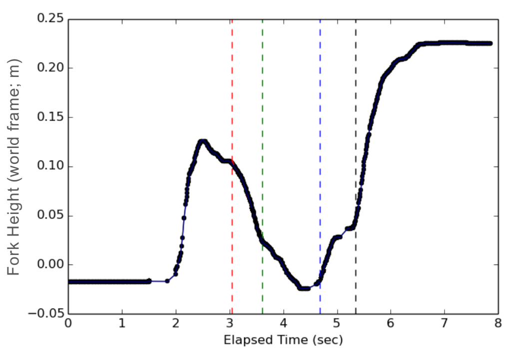


Data Processing: Human Data → Schema

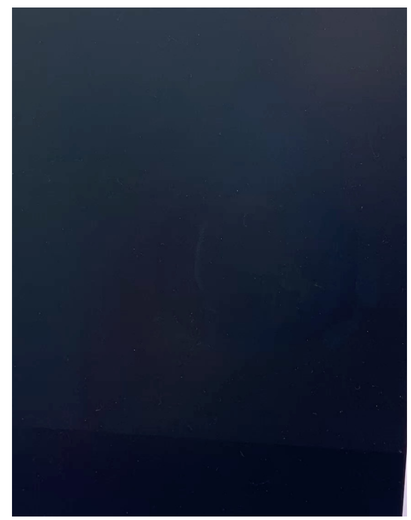
Food Detection

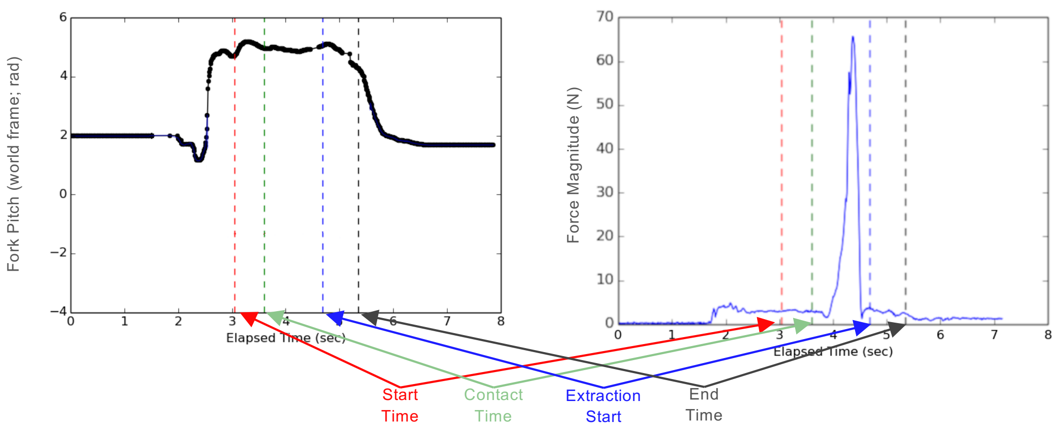




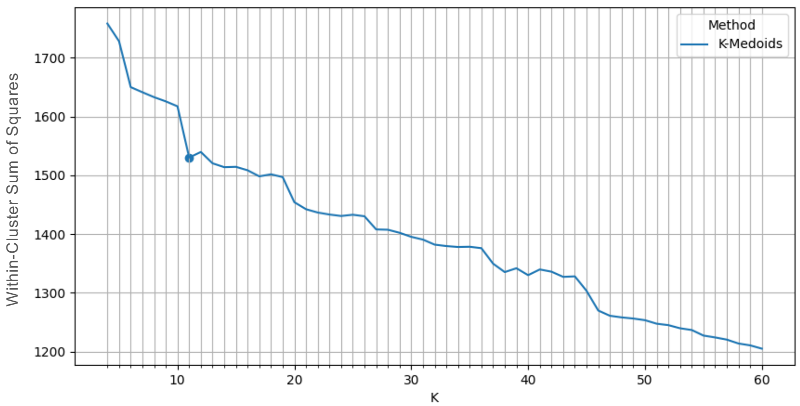


1. Segment food masks (above).
2. Extract key timestamps, based on fork position.
3. Extract "approach" parameters by linearly extrapolating fork back from contact.
4. Extract "grasp" and "extraction" twists using start + end poses at the timestamp.





Clustering Representative Actions



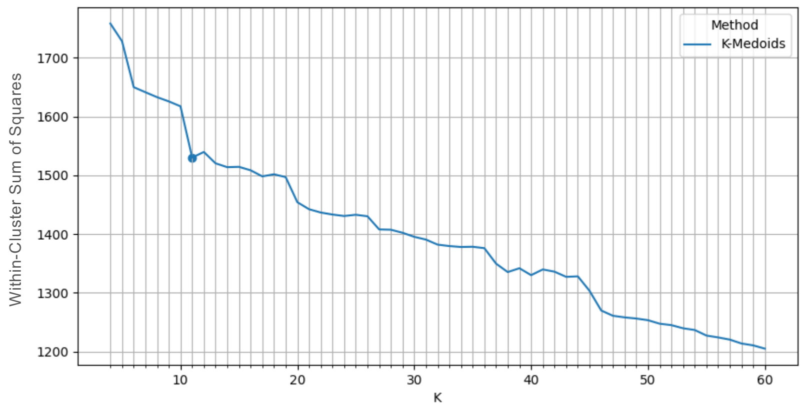
k-medoids on standardized actions

k=11 (elbow point)

Action 6; Mashed Potato

Scooping

Clustering Representative Actions



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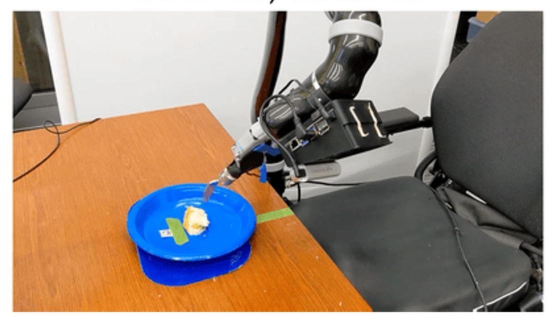
Action 10; Sandwich

Tilted Tines for Higher Pressure



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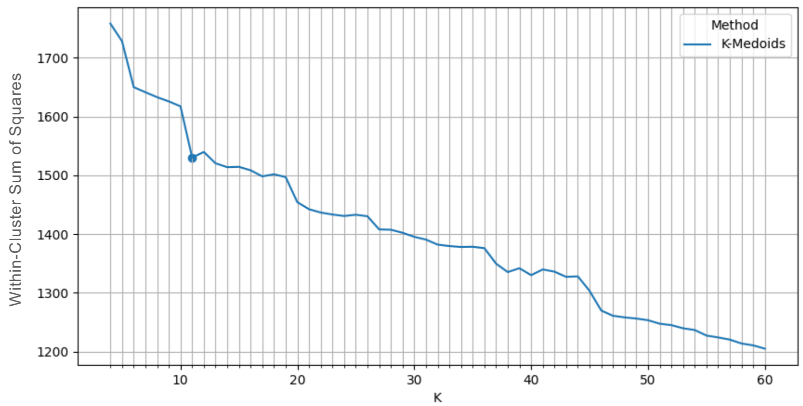

k-medoids on standardized actions

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Action 6; Mashed Potato

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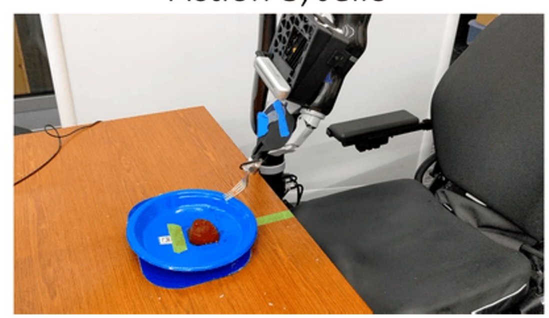
Action 8; Jello

Tilted Extraction



Evaluating Actions

Action 6; Mashed Potato

Scooping

Action 10; Sandwich

Tilted Tines for Higher Pressure

Action 8; Jello

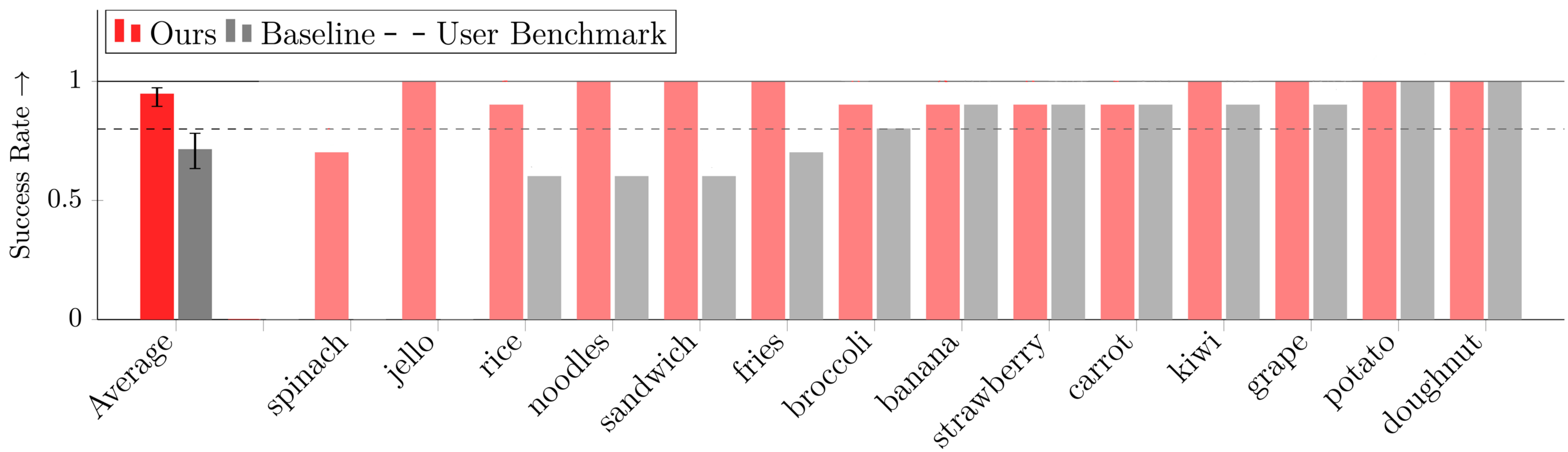
Tilted Extraction

1. **Coverage**

2. **Learnability**

14 food items (9 unseen)

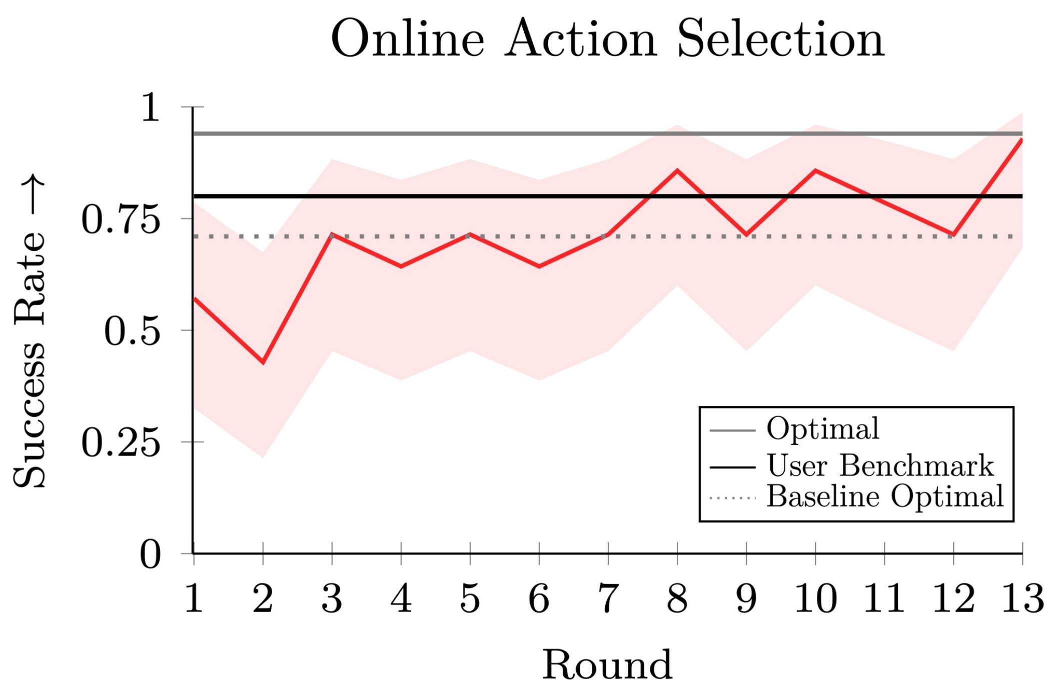
Evaluating Actions: Coverage



For every food but single-leaf spinach, there exists an action to acquire it with ≥ 80%* success.

* Bhattacharjee, Tapomayukh, et al. "Is more autonomy always better? exploring preferences of users with mobility impairments in robot-assisted feeding." *HRI*. (2020)

Evaluating Actions: Learnability

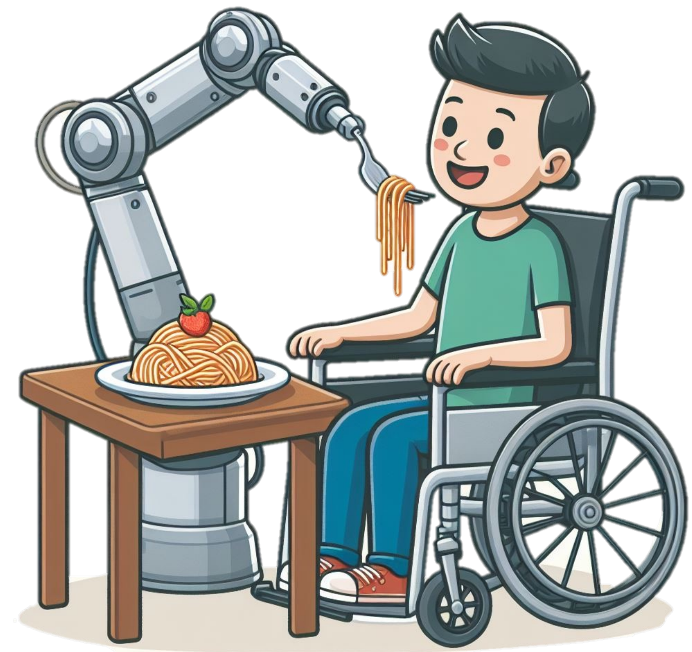


Error Bars: Wilson 95% confidence intervals

~30s / acquisition → learn optimal action in ~4m of pre-meal training!

Roadmap

1. Motivation
2. Robot-Assisted Feeding Overview
3. RQ1: Users' Needs Assessment
4. RQ2: Generalizing Bite Acquisition
5. RQ3: Developing a Deployable System
6. Evaluations & Lessons Learned



generalize across users

usable without researcher intervention

generalize across environments

How can we develop a **deployable** robot-assisted feeding system that enables **any* user,** in **any* environment,** to feed themselves a meal of their choice†, while **aligning with their preferences**?

customized

generalize across foods

RQ3: How can we develop a robot-assisted feeding system to feed users in diverse out-of-lab and in-home contexts?

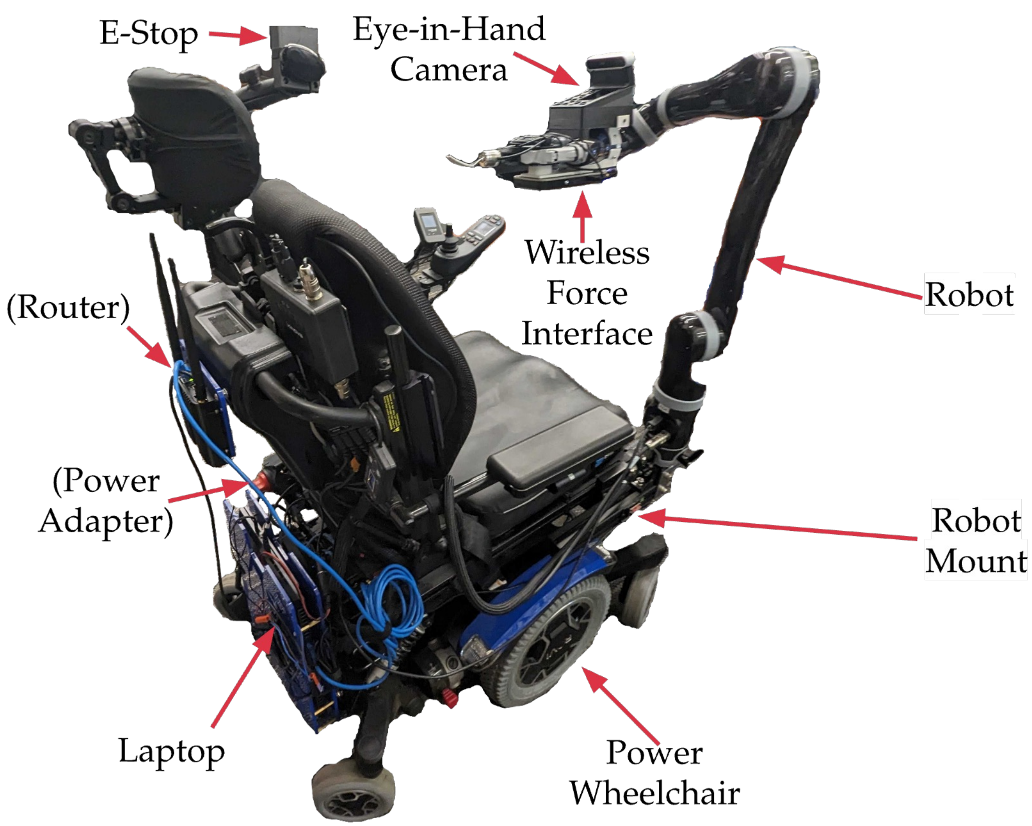
Nanavati, Amal, et al. "Lessons Learned from Designing and Evaluating a Robot-assisted Feeding System for Out-of-lab Use." *HRI.* (2025)

Gordon, Ethan K*, Jenamani, Rajat K*, **Nanavati, Amal***, et al. "An Adaptable, Safe and Portable Robot-Assisted Feeding System." *HRI*. (2024)
Best Demo Award 🏅

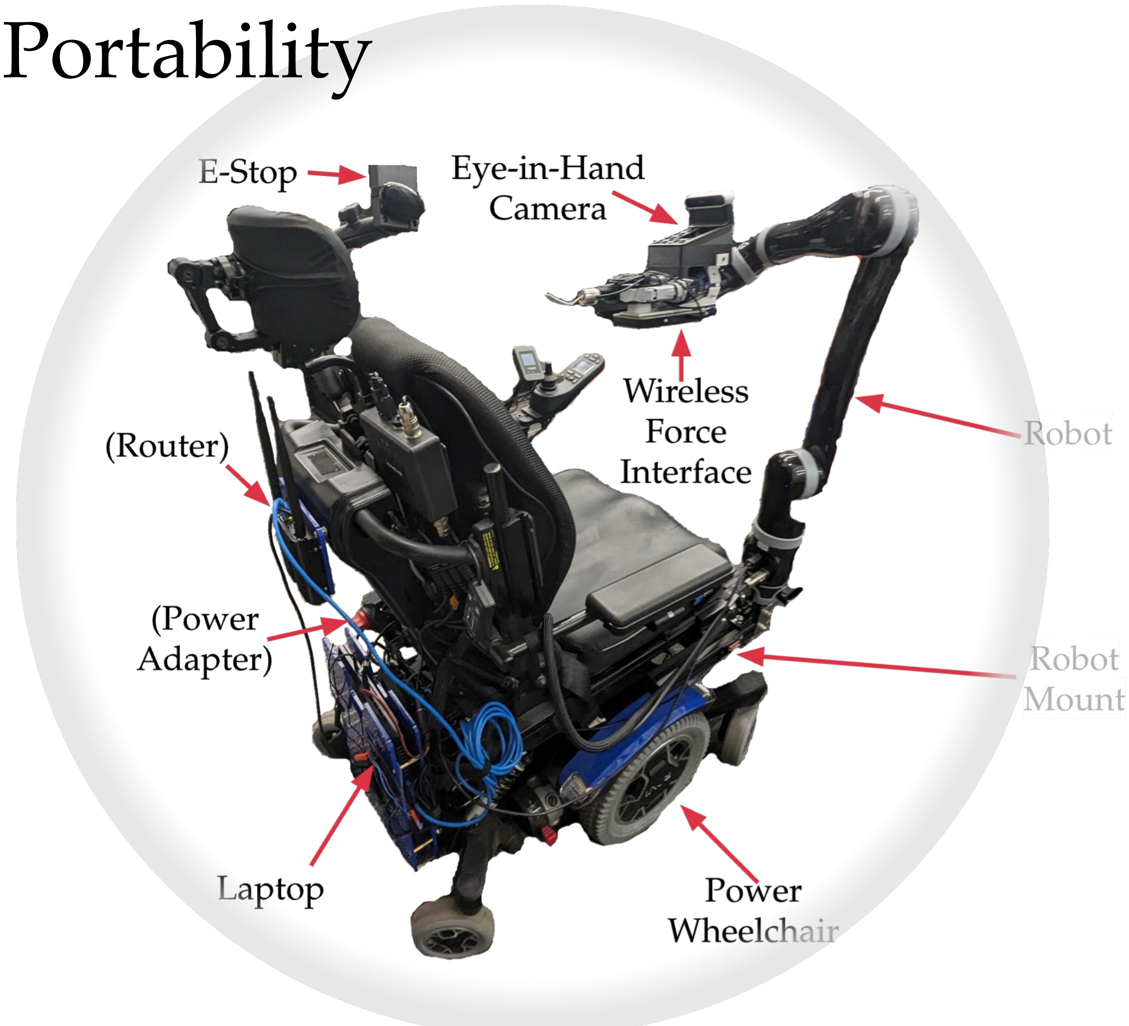
RQ3: Key System Design Principles for Deployability

1. Portability
2. Safety
3. User Control
4. Customizability

Portability

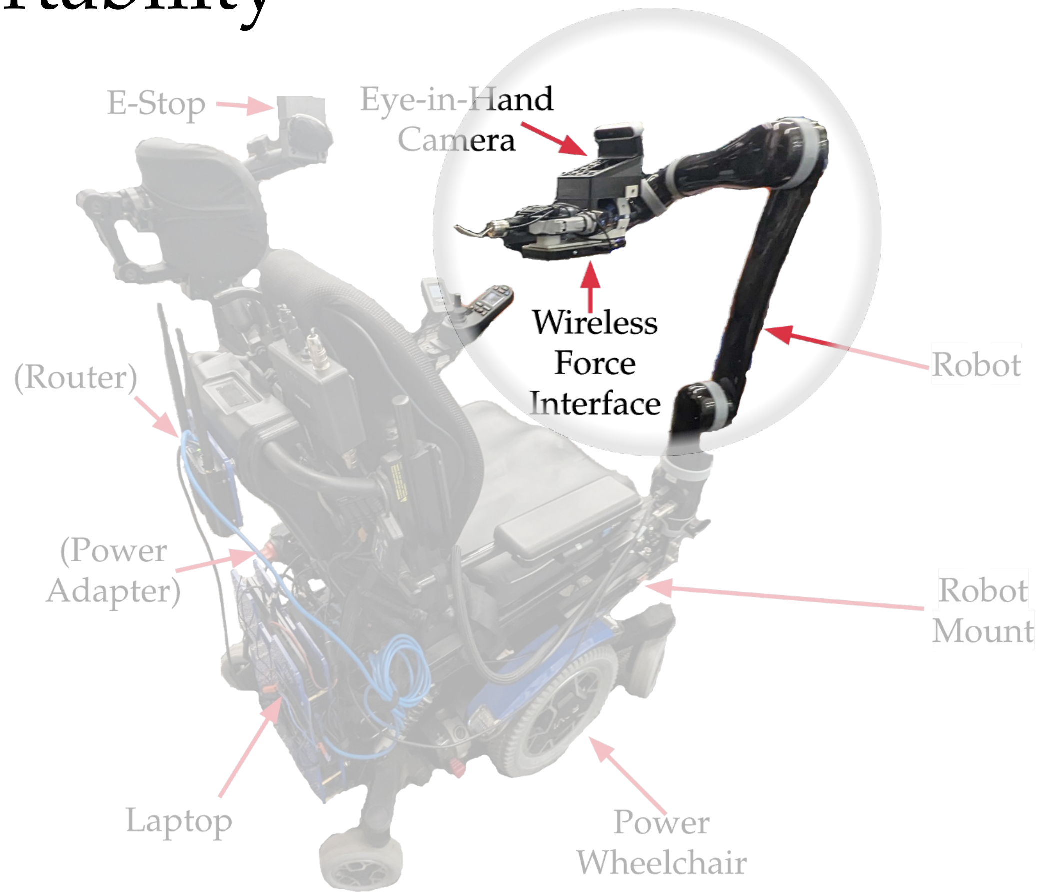


Portability



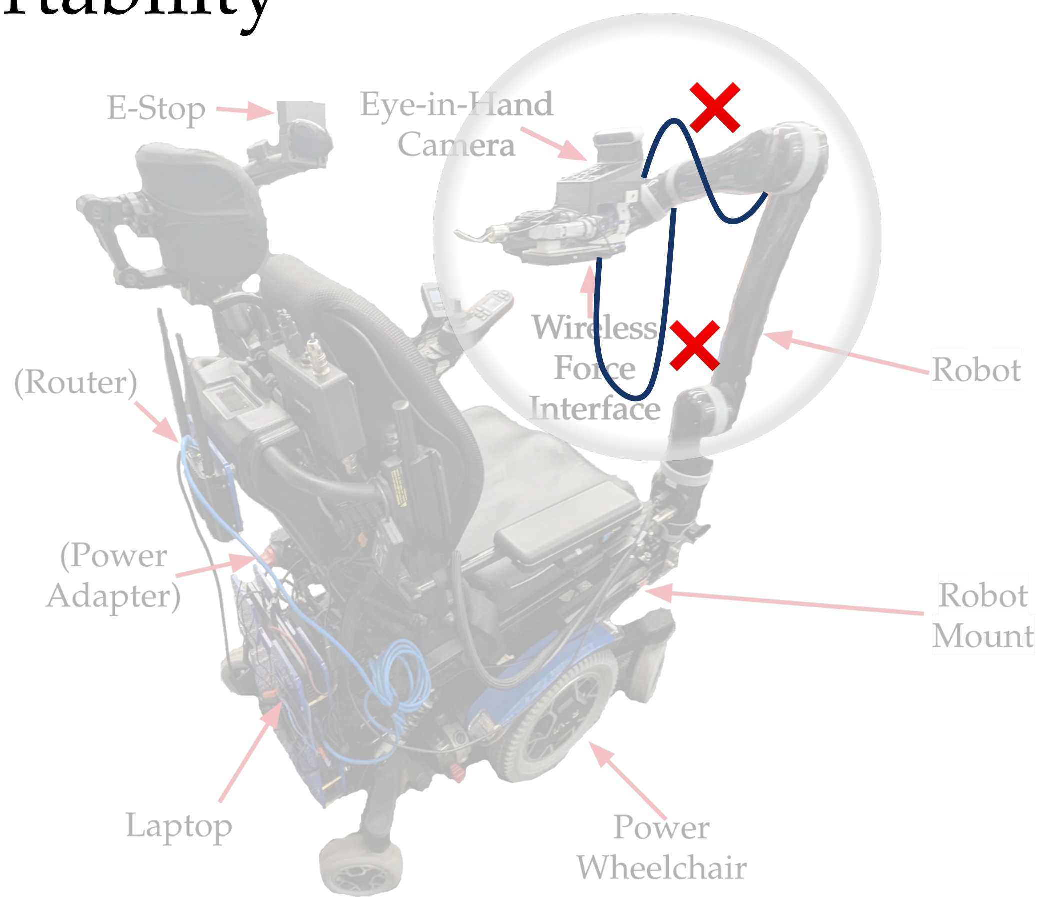
No wires leave the system

Portability



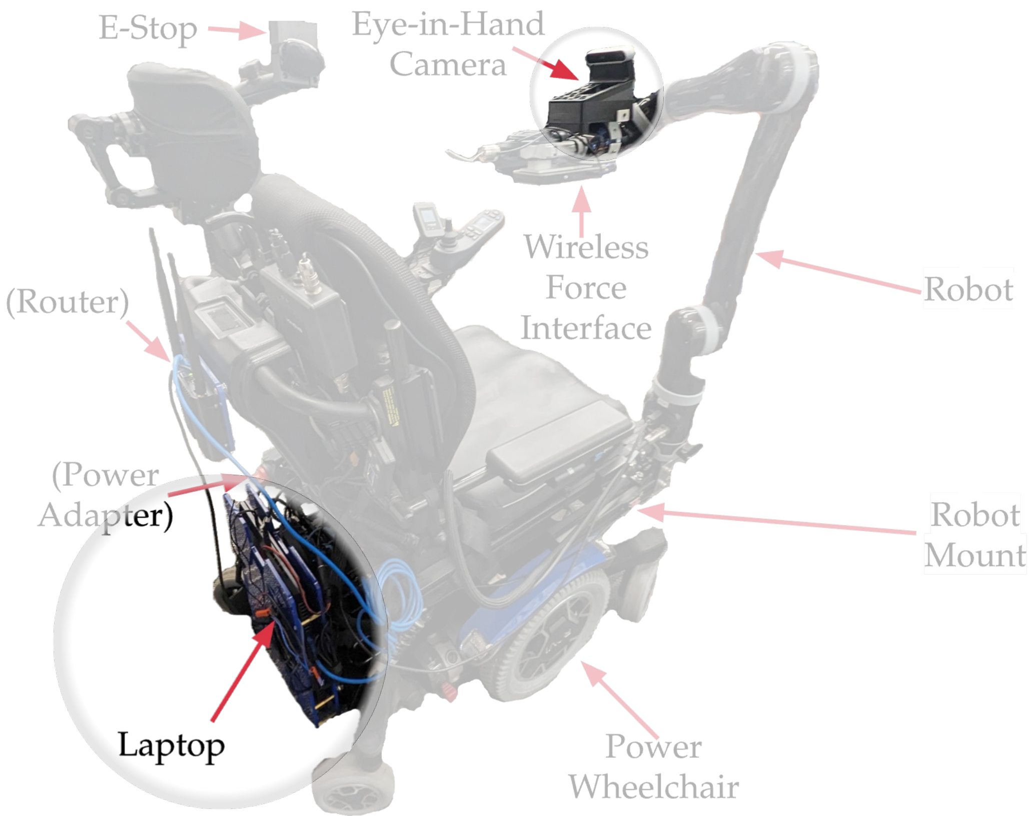
No wires across robot joints

Portability



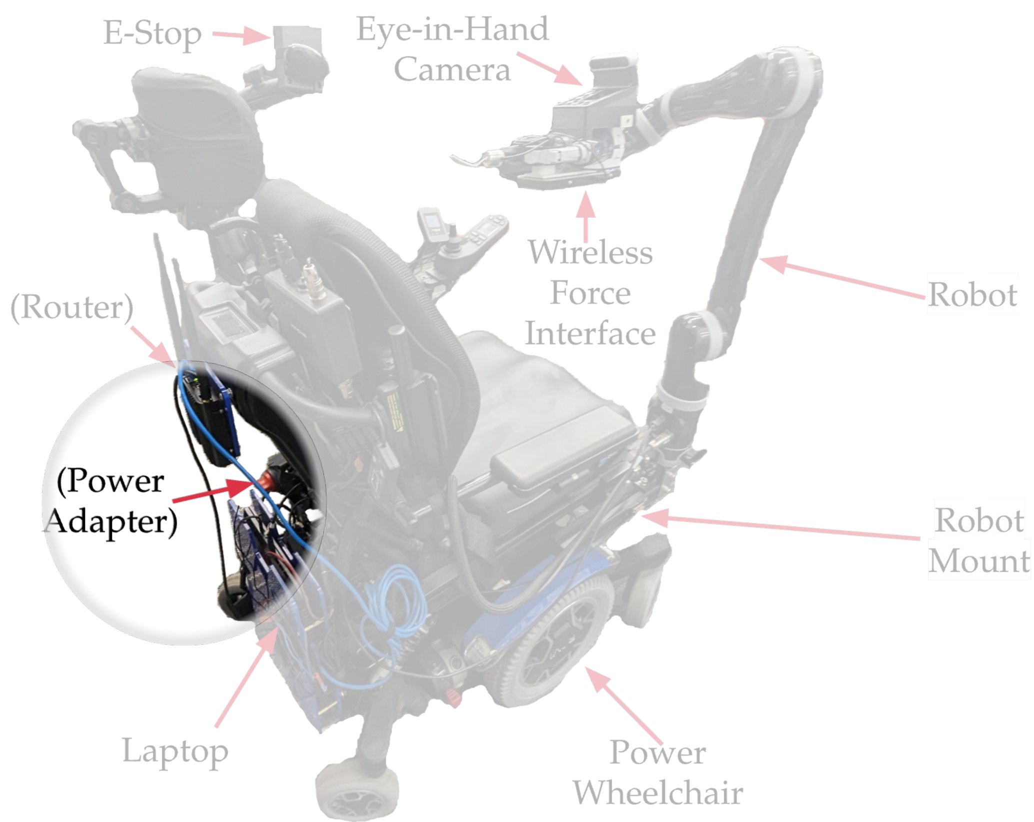
No wires across robot joints

Portability



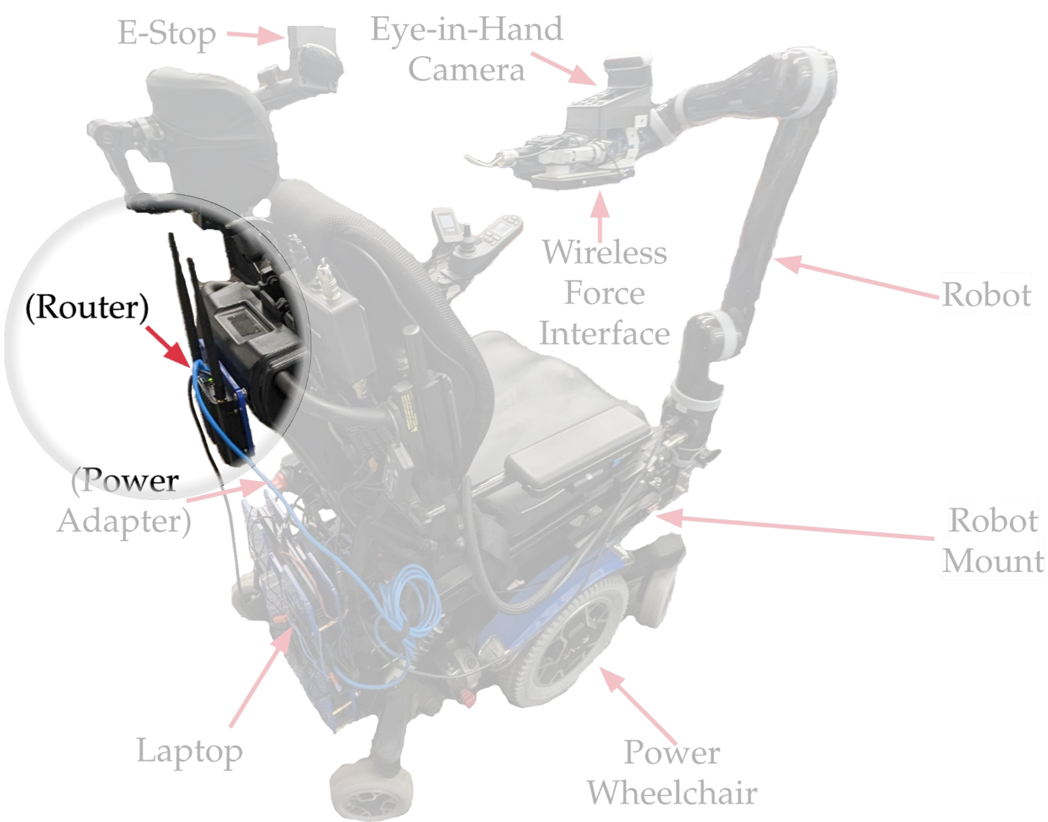
Portable compute

Portability



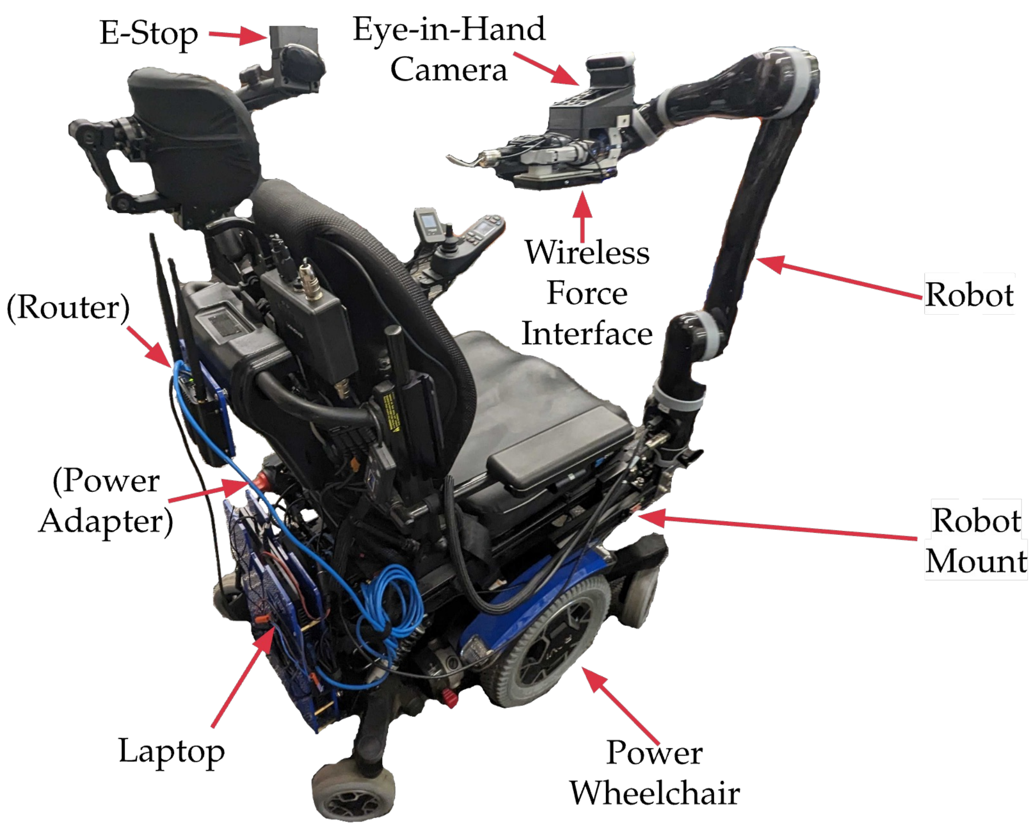
Portable power

Portability

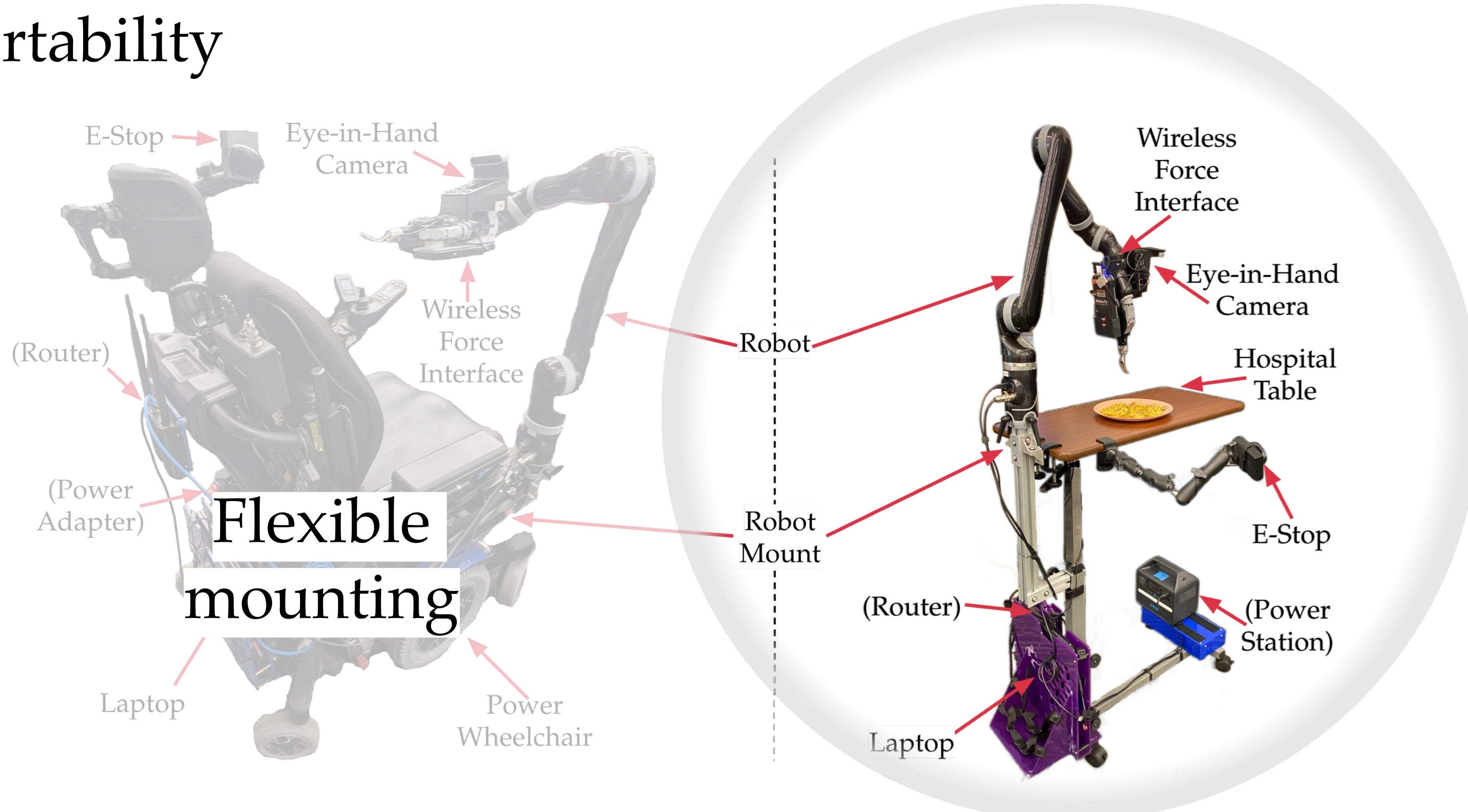


Portable networking

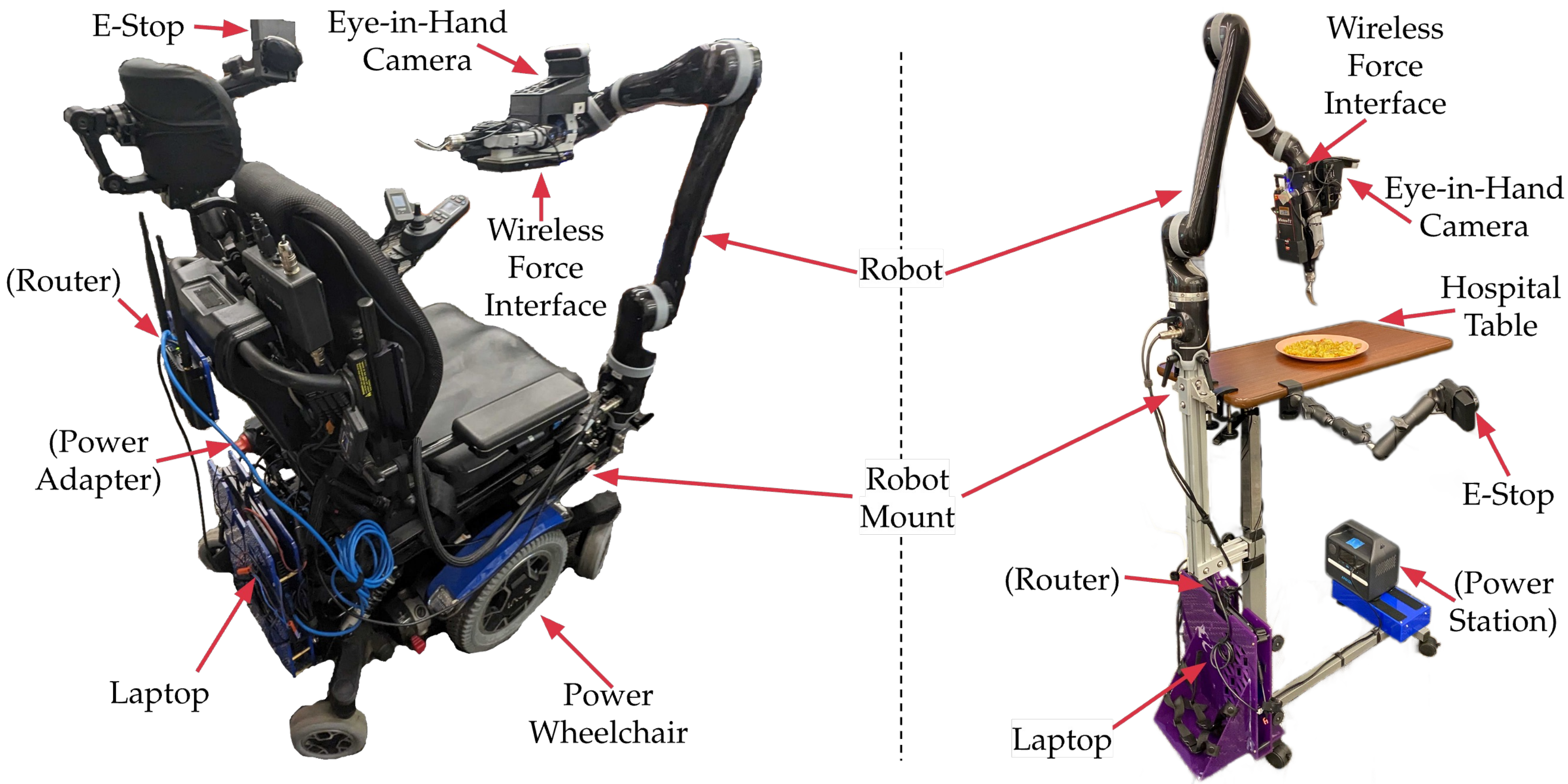
Portability



Portability



Portability



RQ3: Key System Design Principles for Deployability

1. Portability

2. Safety

3. User Control

4. Customizability

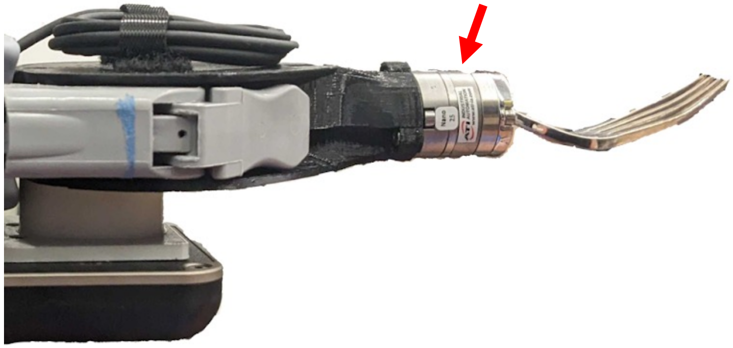
What Can Go Wrong? Understanding Off-Nominals

User	**Robot**	**Environment**
User no longer wants bite	Robot collides with object	Food falls off the fork
User cannot eat (e.g., is coughing)	Robot fails to perceive bite	Plate moves (e.g., caregiver serves food)
User takes a partial bite	Robot fails to acquire bite	Local area network fails
User clicks unintended button	Robot stops far from face	Device running web app fails
…	…	…

The multitude & diversity of off-nominals makes it challenging to develop a deployable robot feeding system.

Low-Level Safety Protections Against Off-Nominals

- Force-gated
  - controllers stop if force-threshold is exceeded
- E-stop
  - controllers stop if e-stop button pressed
- Watchdog ensures liveness of safety system
  - controllers stop if haven't received "all-clear" watchdog message in n ms
- This is about *preventing negative outcomes* from off-nominals.
- What about *resolving* them to resume the meal?



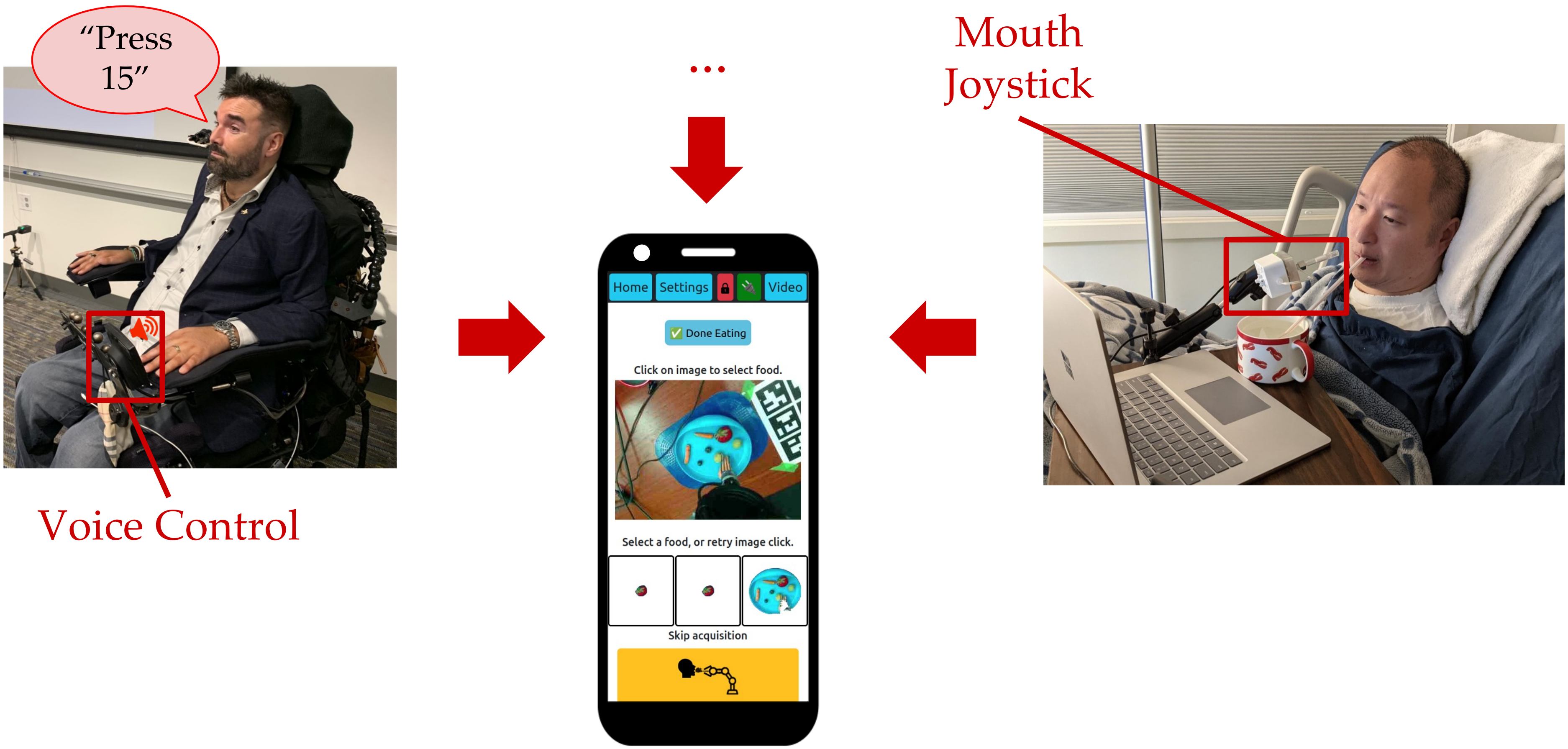
Key Observation:

Users' goal fully aligns with the robot, they are co-located and temporally synchronized with the robot, and desire control over the robot.

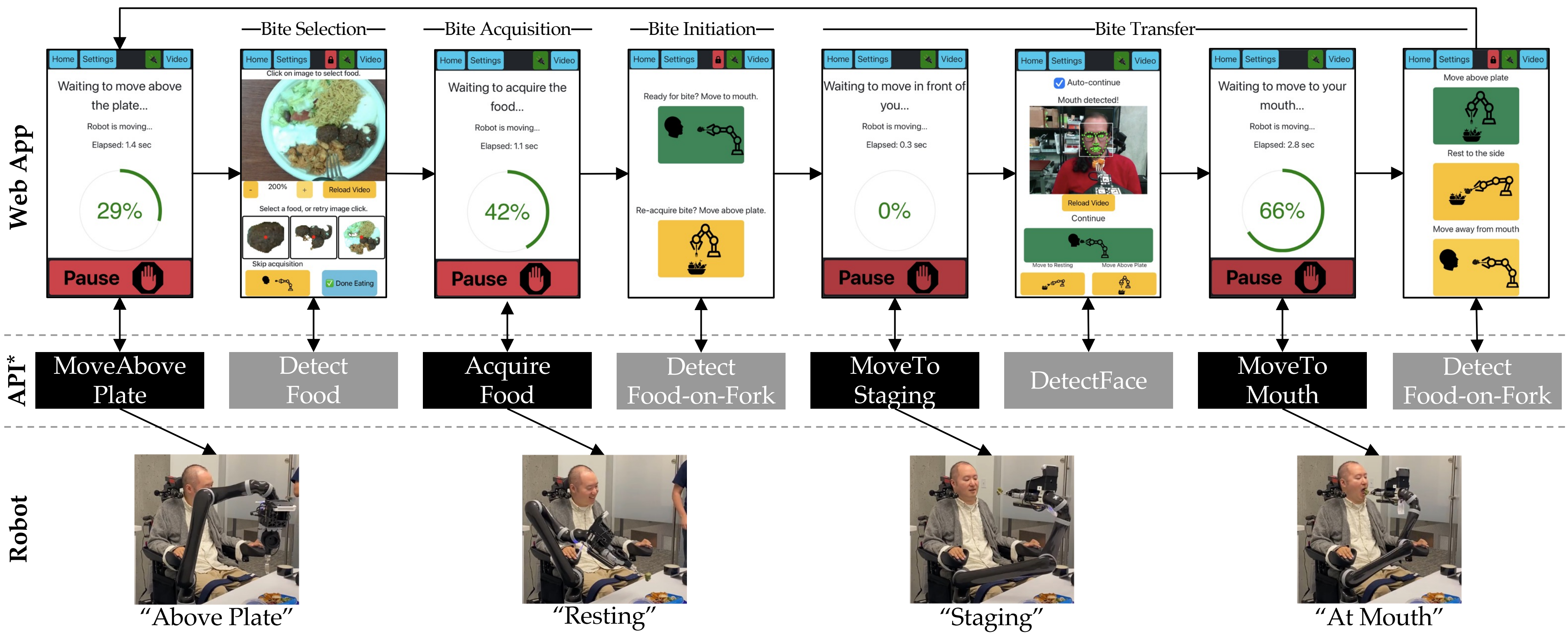
Key Insight :

Users can resolve off-nominals, given control and transparency.

User Interface: **Web App**

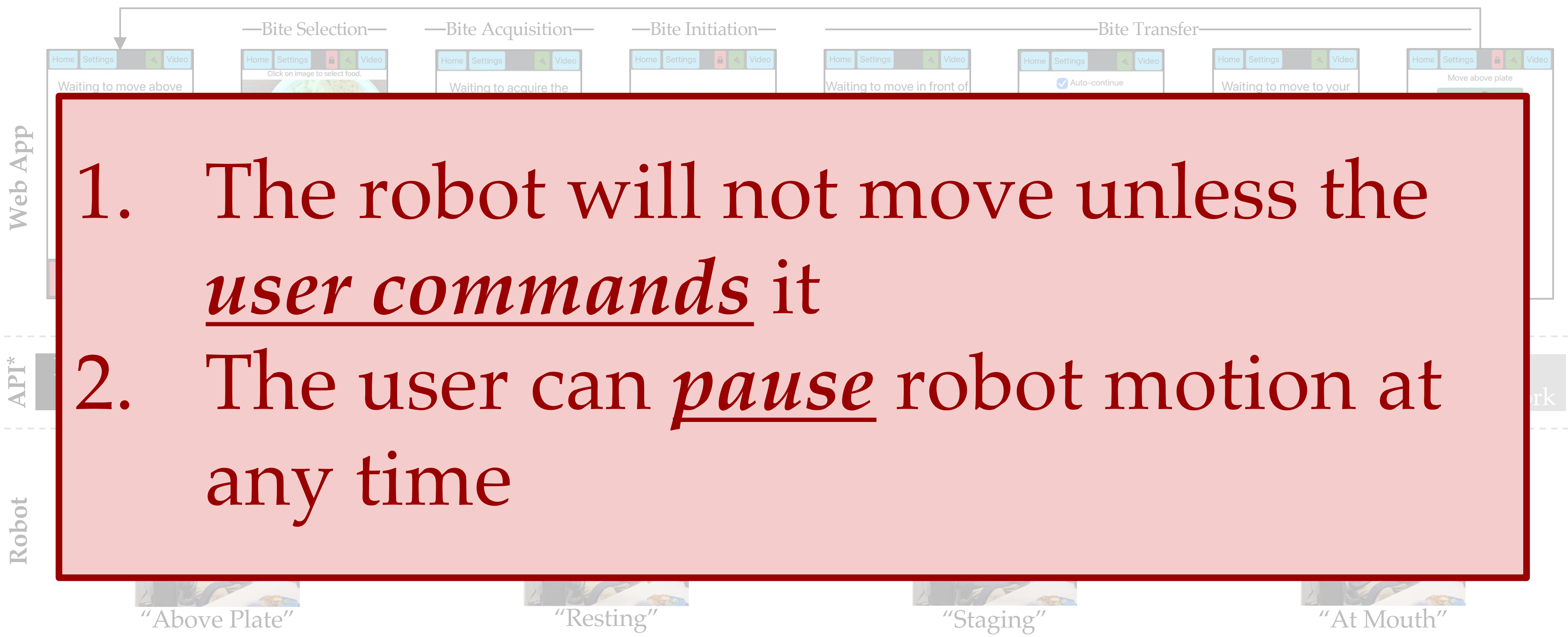


System Overview: **User Controls Execution**



* Robot actions are implemented as behavior trees

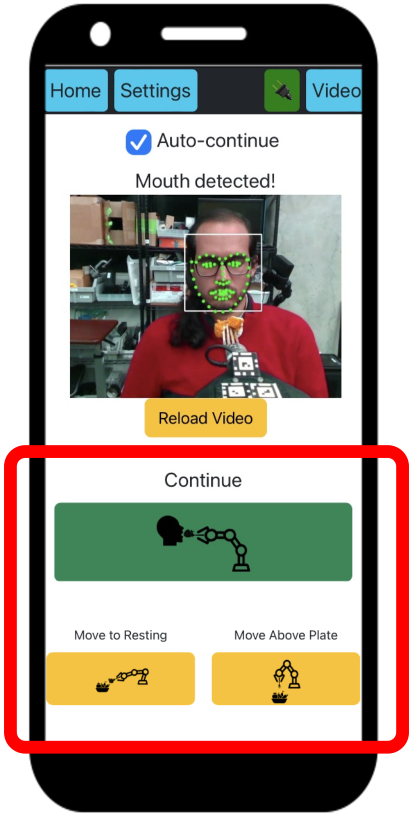
System Overview: **User Controls Execution**

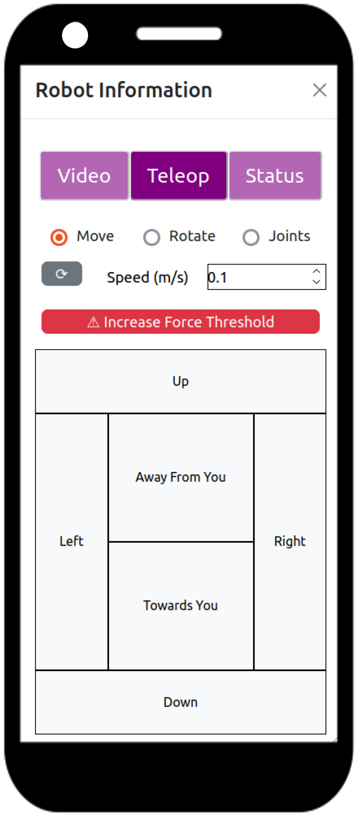


1. The robot will not move unless the ***user commands*** it
2. The user can ***pause*** robot motion at any time

* Robot actions are implemented as behavior trees

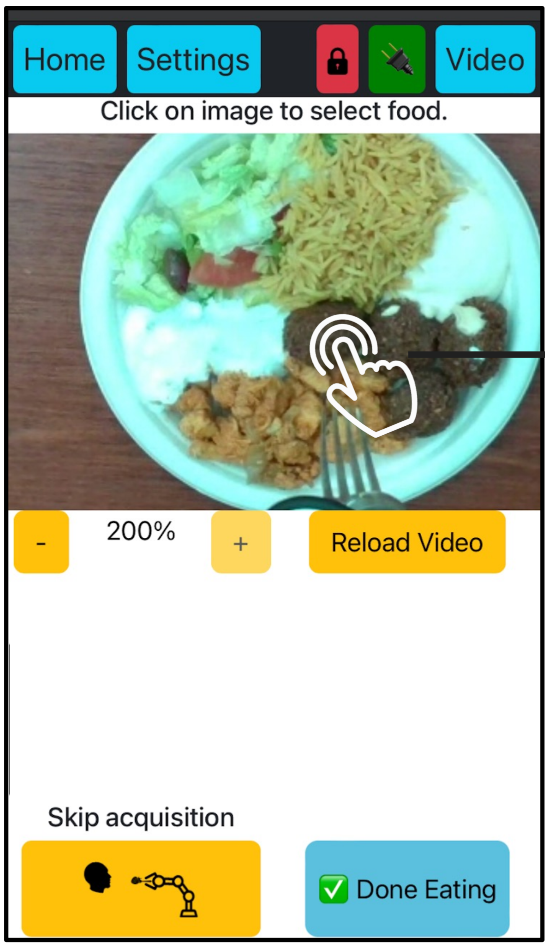
Flexible User Control is key to resolve off-nominals





* Cartesian control provided via the
Selectively Damped Jacobian Pseudo-Inverse

Transparency is necessary to enact user control



image, seed point

Segment Anything Model (SAM)

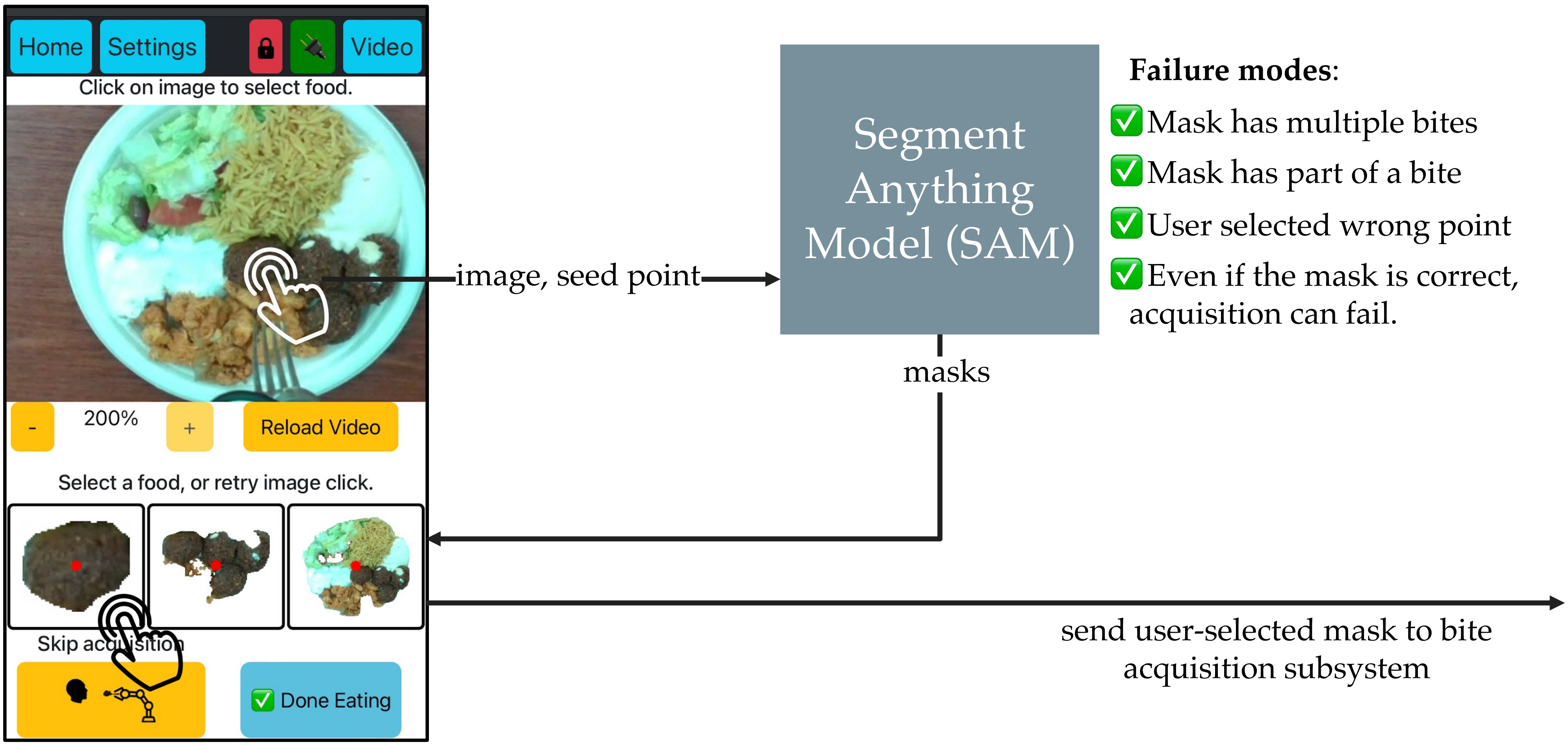
masks

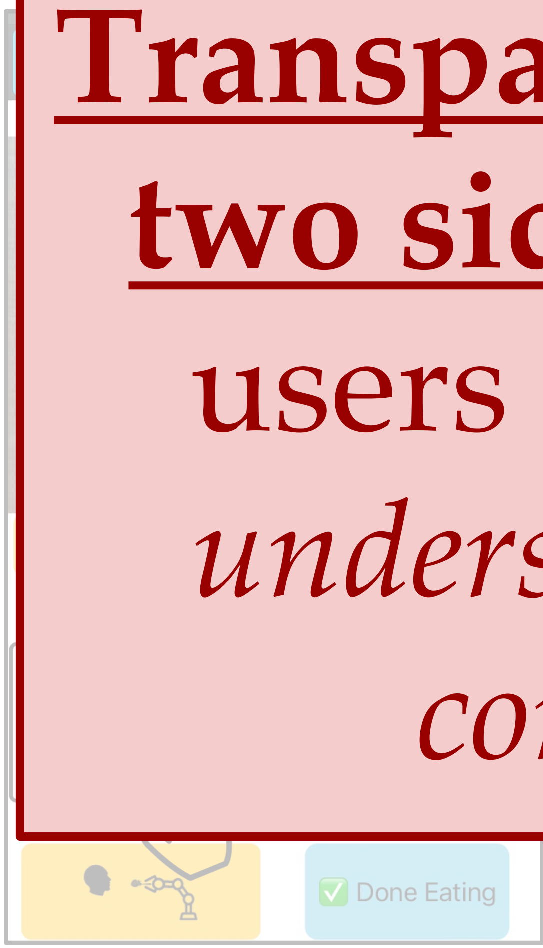
Failure modes:

- Mask has multiple bites
- Mask has part of a bite
- User selected wrong point
- Even if the mask is correct, acquisition can fail.

send most confident mask to bite acquisition subsystem

Transparency is necessary to enact user control





<u>Transparency and control are two sides of the same coin</u>; users need *transparency to understand* a problem and *control to resolve* it.

acquisition subsystem

RQ3: Key System Design Principles for Deployability

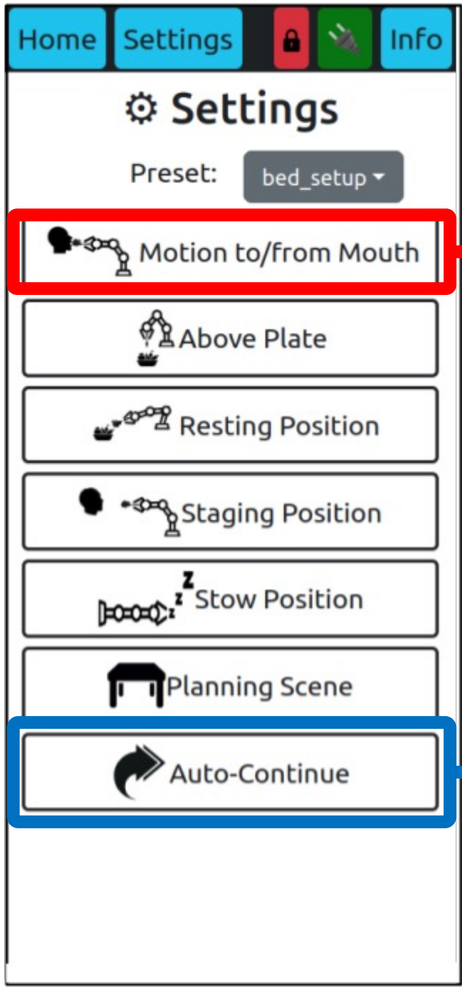
1. Portability

2. Safety

3. User Control

4. Customizability

Customizability

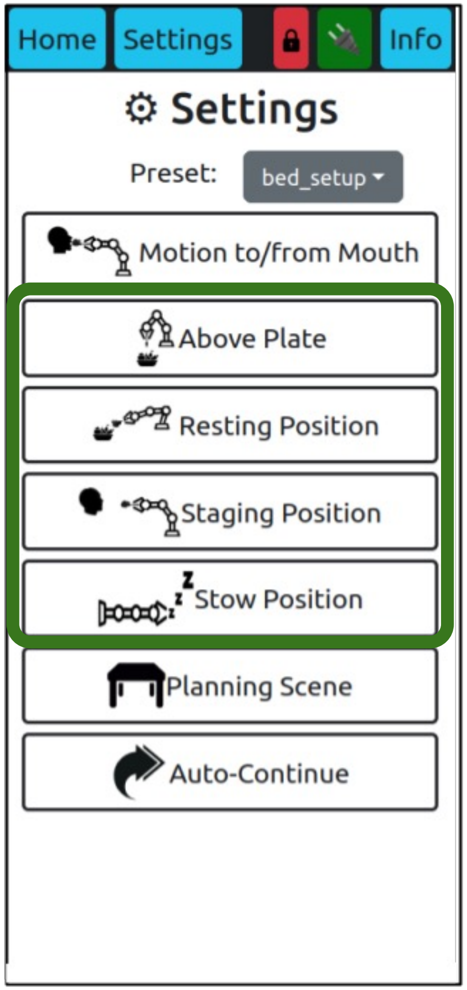


- distance to mouth
- speed to/from mouth

At each transition, does the robot wait for user input, or auto-continue?

- post-acquisition
- pre-transfer
- post-transfer

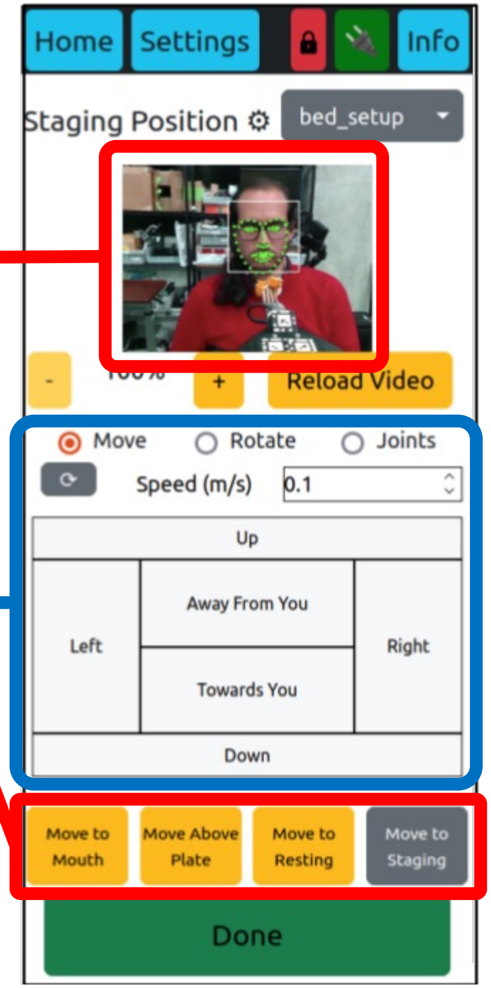
Customizability: Arm Configurations



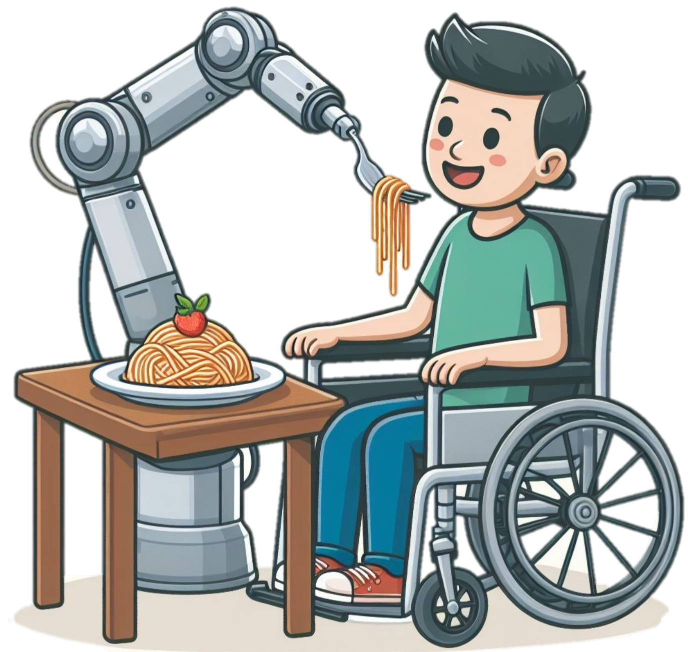
transparency into upstream impacts of customization

direct, intuitive access to parameter space

Resnick, Mitchel, and Eric Rosenbaum. "Designing for tinkerability." *Design, make, play: Growing the next generation of STEM innovators* (2013)



Roadmap



Evaluations Overview

1. Quantitative, Multi-User, Out-of-Lab
2. Qualitative, Single-User, In-Home

Evaluation 1: Quantitative, Multi-User, Out-of-Lab

How does the system perform across the needs / preferences of *different users*?

- 5 participants & 1 community researcher
- Meal of their choice
- 3 locations: office, conference room, public cafeteria
- Used their own devices and assistive technologies

User ID	Age	Gender	Impairment	Selected meal(s) items[17]	Study location(s)	Device interaction
P1	49	M	C3 SCI[18]	Pizza, broccoli	Conference room	Voice control
P2	42	F	C5 SCI	Chicken, salad	Office	Stylus
P3	45	M	Arthrogryposis	Sandwich, brownies	Conference room	Stylus
P4	62	M	C3 SCI	Chicken, potatoes	Office	Touch
P5	61	F	C5-6 SCI	Salmon, brussels	Office	Touch
CR2	43	M	C2 SCI	Stir-fry beef, tofu	Cafeteria	Mouth joystick

Evaluation 1: Bite Acquisition

User ID	Acquisition Success Rate	Most Successful Food
P1	0.79 (15/19)	Pizza: 0.78 (14/18)
P2	0.65 (24/37)	Chicken: 0.85 (11/13)
P3	0.69 (31/45)	Sandwich: 0.94 (16/17)
P4	0.88 (30/34)	Chicken 1.0 (13/13)
P5	0.79 (23/29)	Brussels: 0.86 (6/7)
CR2	0.78 (14/18)	Tofu: 1.0 (3/3)

Evaluation 1: Bite Duration

User ID	Median Bite Time (IQR)
P1	2:26 (0:54)
P2	1:10 (0:12)
P3	1:00 (0:09)
P4	1:10 (0:21)
P5	1:15 (0:20)
CR2	1:41 (0:24)

Full Teleop: ≥ 5 mins / bite

With Robot: ≥ 1 min / bite

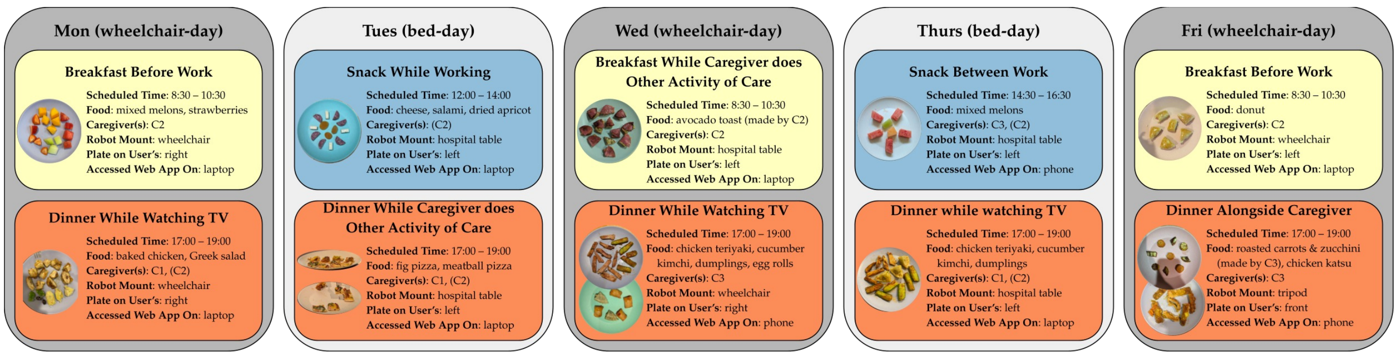
Caregiver: ≥ 20s / bite

Evaluation 1: Subjective Data

User ID	Cognitive Workload (Baseline: 37 [95])	Usability Grade (Baseline: C [92])
P1	17.50	D
P2	29.17	C
P3	38.33	F
P4	20.00	A+
P5	19.17	B+
CR2	19.17	A

Evaluation 2: Qualitative, Single-User, In-Home

How does the system perform across the *different contexts* that arise in-home?



Jonathan Ko

Evaluation 2: Spatial Context

Bed-Days

Wheelchair-Days

Evaluation 2: Social Context

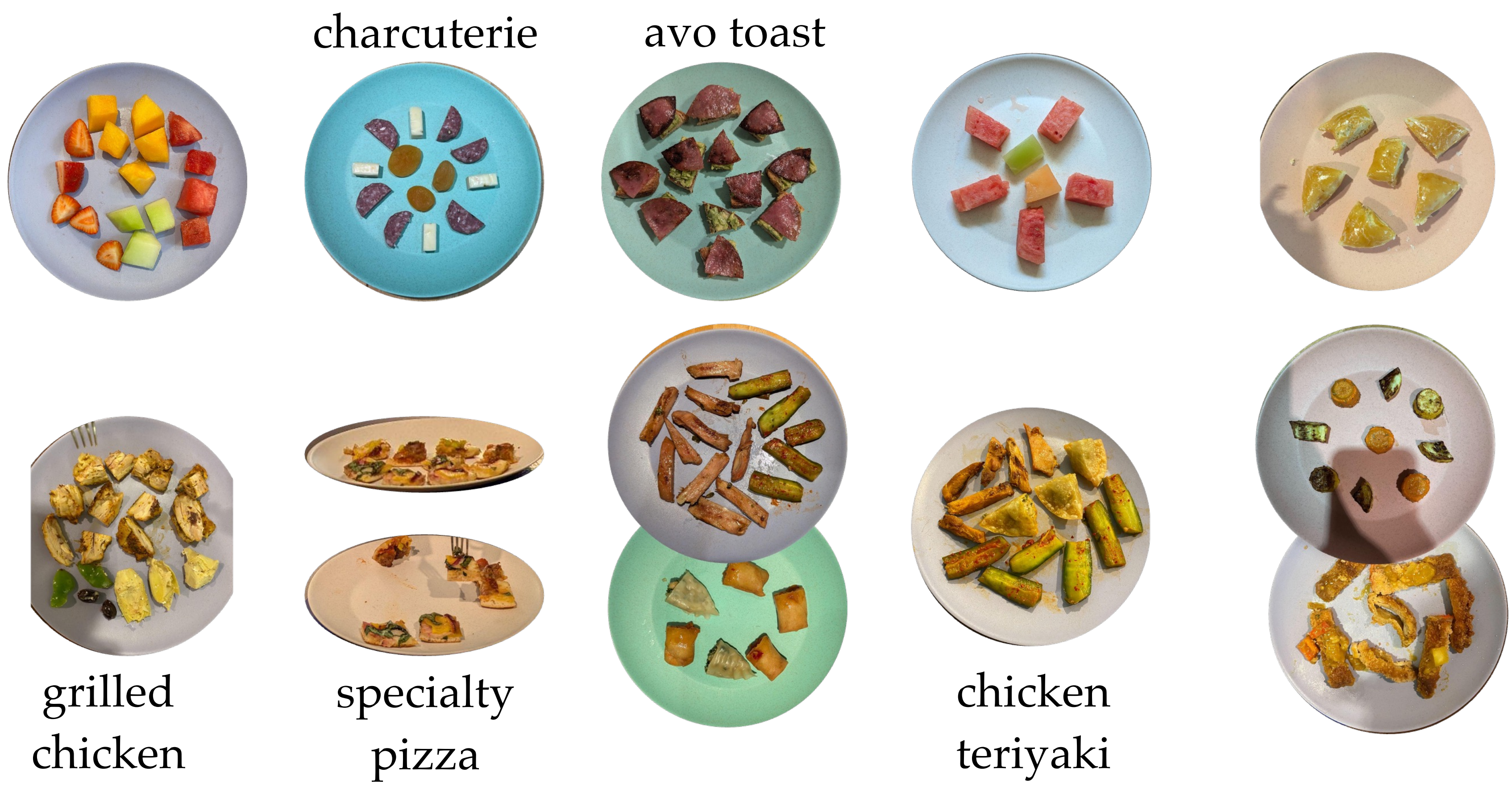
ID	Age Group	Gender	Years Worked with CR2	Live-in?
C1	25–34	F	0.5	✗
C2	55–64	M	25	✓
C3	35–44	F	7	✗

Evaluation 2: Activity Context

- Jonathan's deployment goals:
  - Feed himself dinner while watching TV
  - Spend time with a caregiver while both eat
  - Feed himself while a caregiver does other work
  - Feed himself breakfast while working
  - Feed himself a mid-day snack while working

Results & Lessons Learned

Results Overview



How did Jonathan's level of independence change?

Medicare Section GG

6. Independent

5. Setup assistance

with robot — **4. Supervision**

3. Partial assistance

2. Maximal assistance

baseline — **1. Dependent**


Back View
Real-Time (1x)

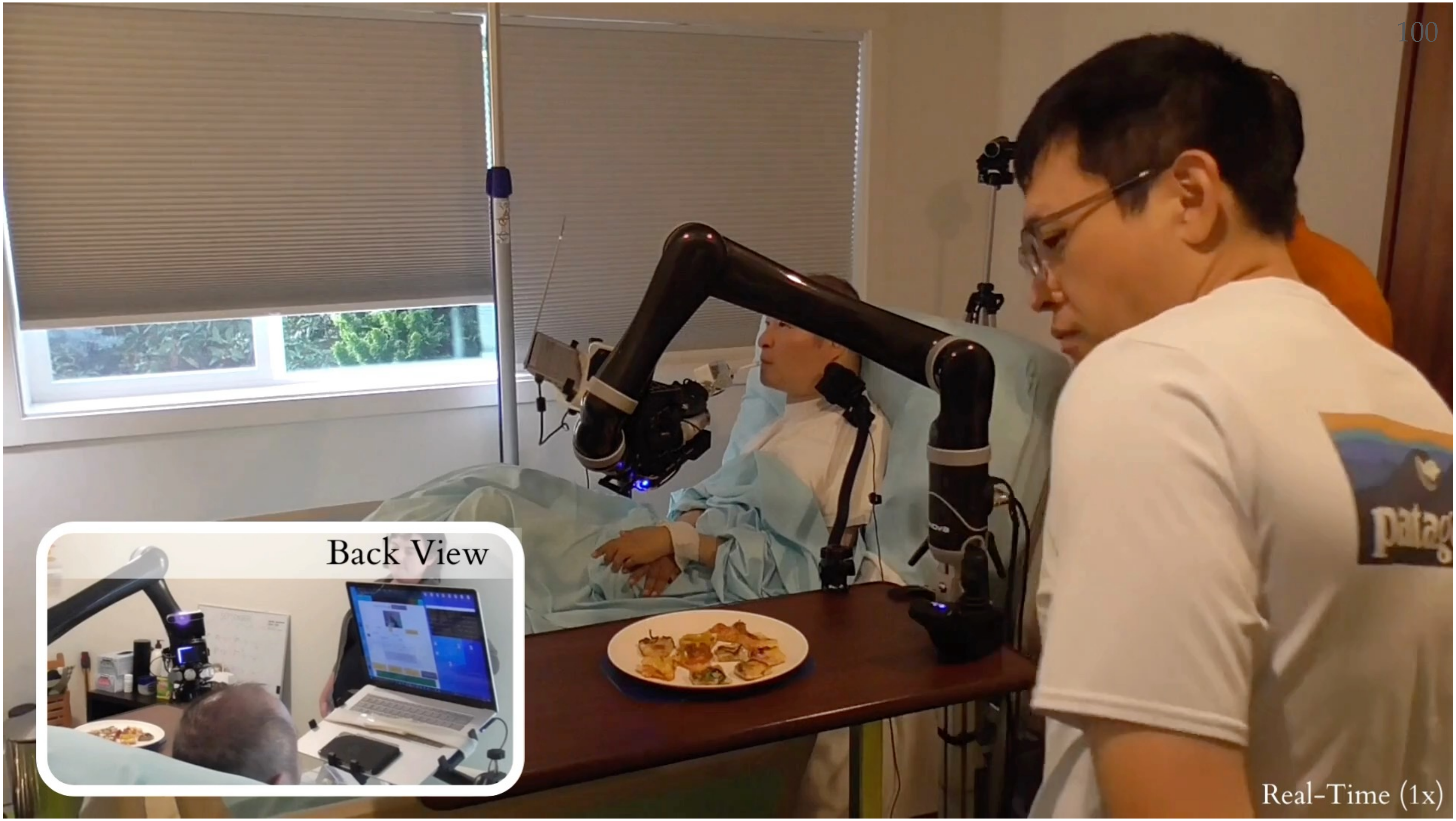
Spatial Contexts

Environmental objects

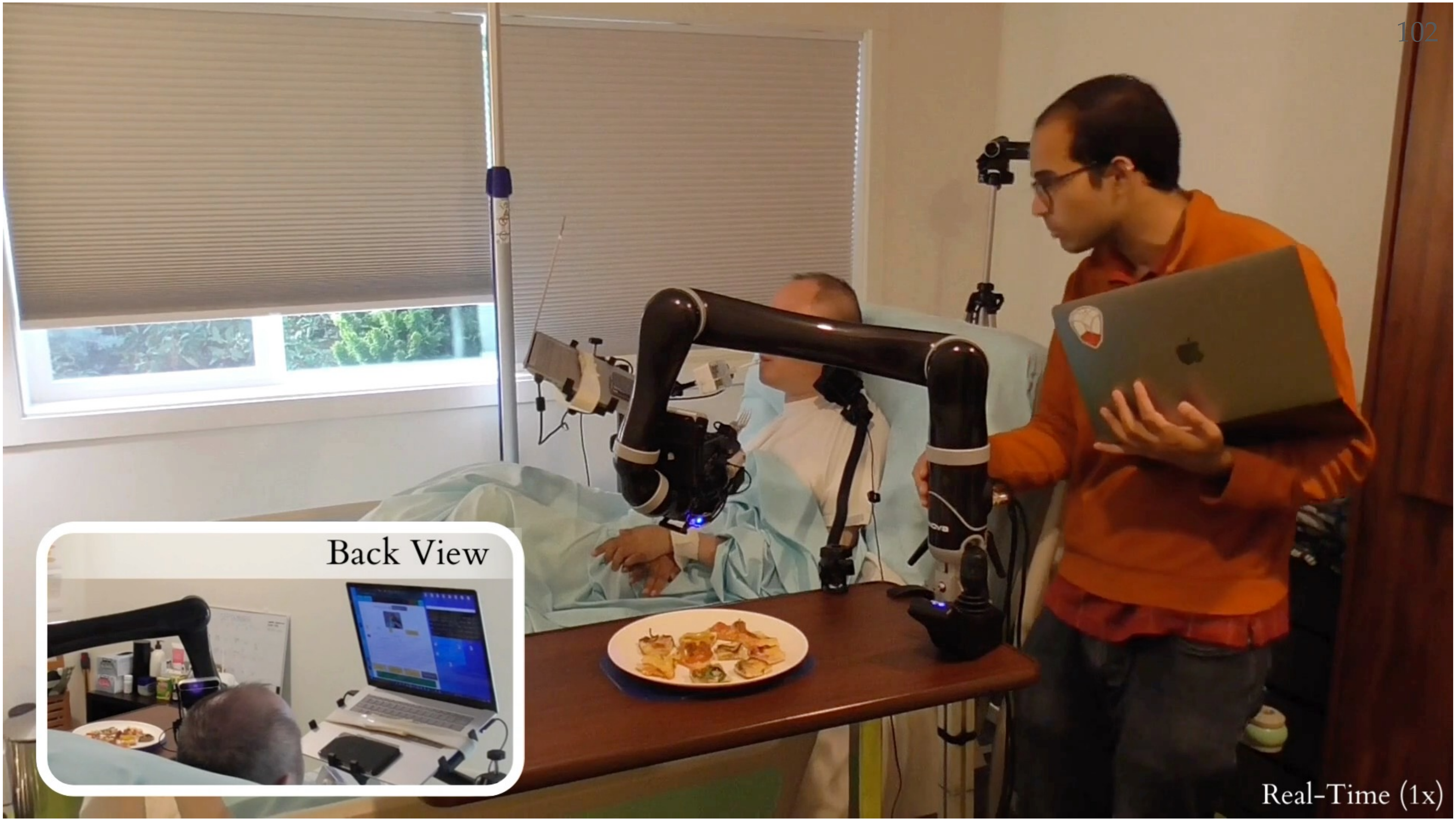
- Laptops / smartphones
- Hospital tables
- Mouth joystick
- E-stop

Variability

- Bed tilt
- User's lateral position in bed
- Wheelchair tilt
- Hospital table height & orientation


100
Back View
Real-Time (1x)


Back View
Real-Time (1x)

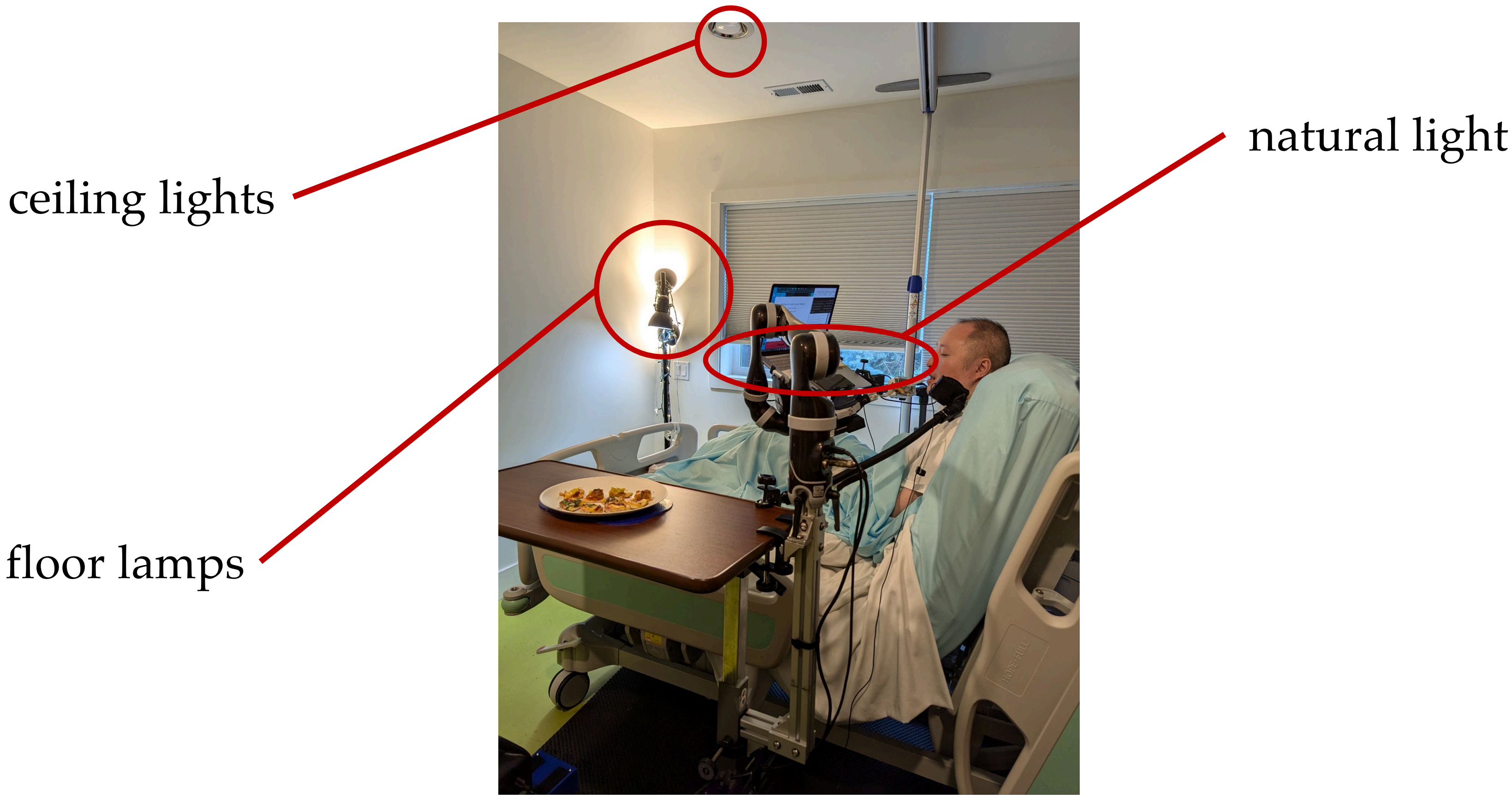

Back View
Real-Time (1x)

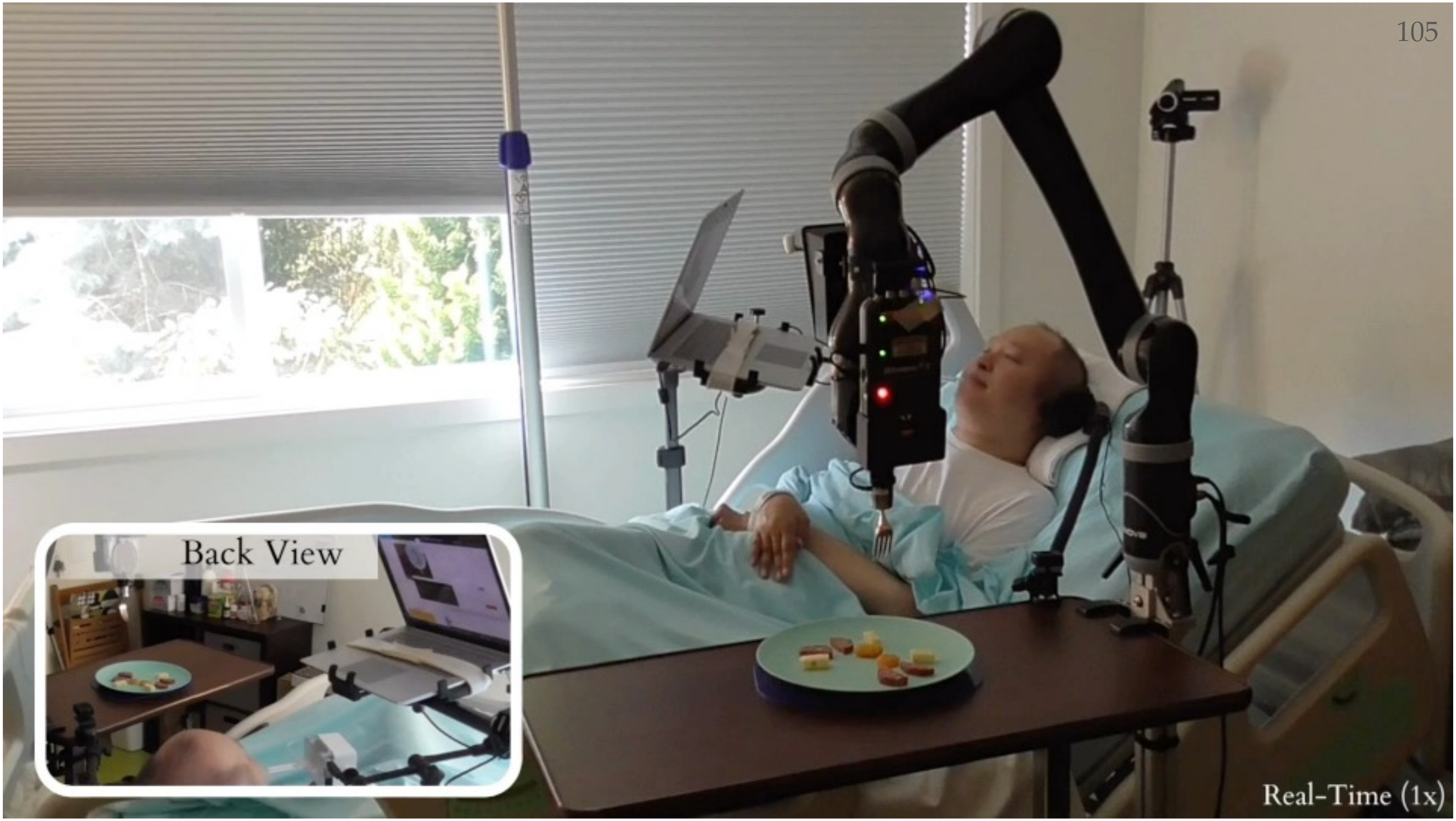
Lesson #1:

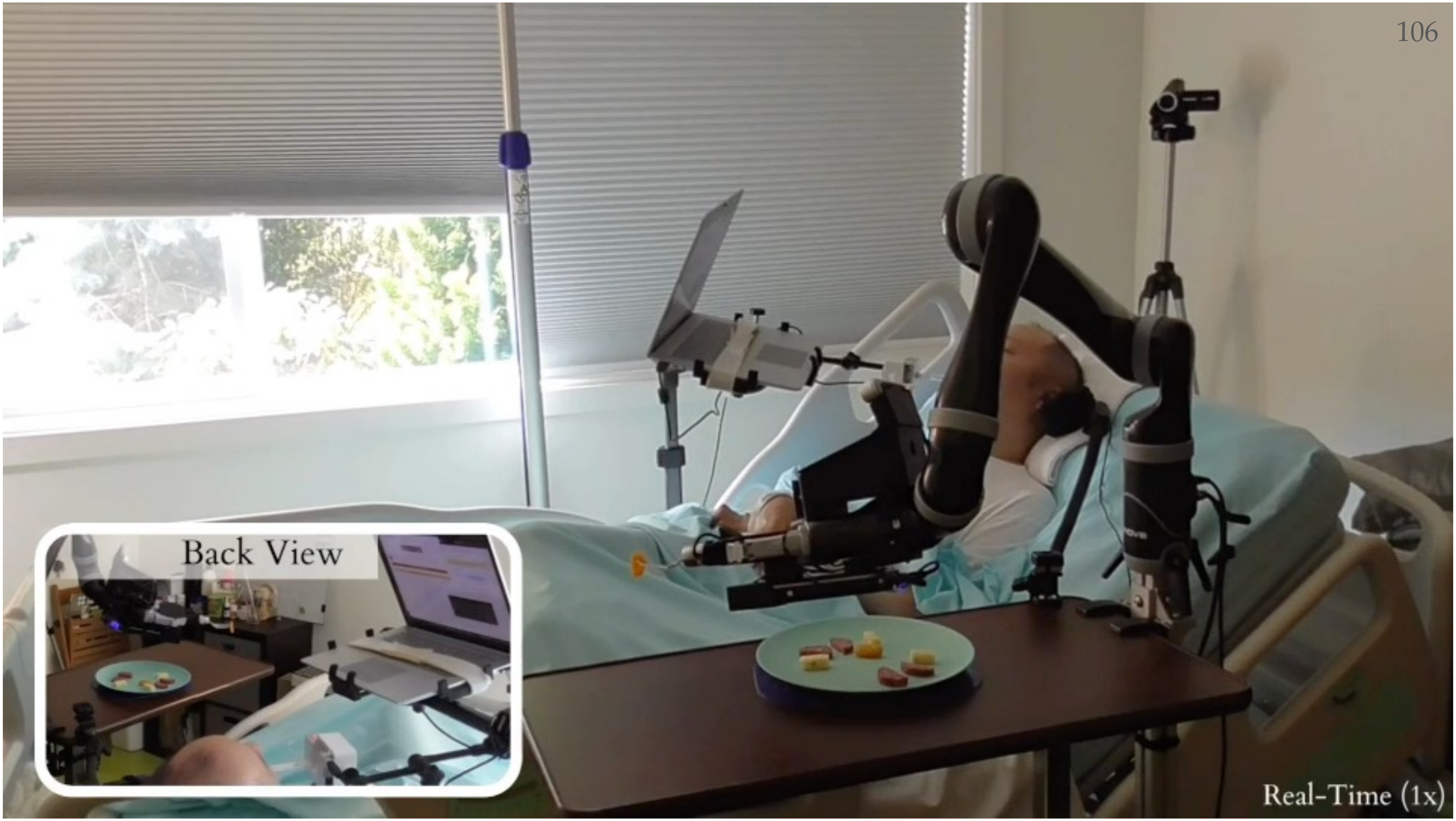
- Spatial contexts are numerous
- Tinkering is inherent to assistive robot setup*
- Customizable systems enable easy tinkering

*Mossfeldt Nickelsen, Niels Christian. "Imagining and tinkering with assistive robotics in care for the disabled." *Paladyn, Journal of Behavioral Robotics* (2019).

Off-nominals: Face Detection




Back View
Real-Time (1x)

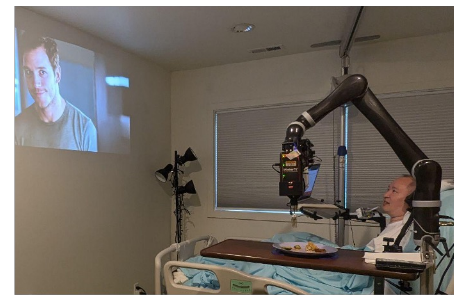

Back View
Real-Time (1x)

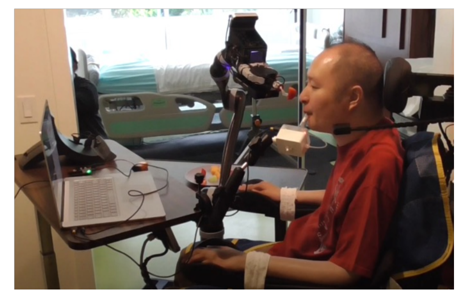
Lesson #2:

- Off-nominals will arise
- Variable autonomy lets users overcome them

Jonathan’s Goal Attainment

- ✅ Feed himself dinner while watching TV
- ✅ Spend time with a caregiver while both eat
- ✅ Feed himself while a caregiver does other work
- ❌ Feed himself breakfast while working
- ❌ Feed himself a mid-day snack while working





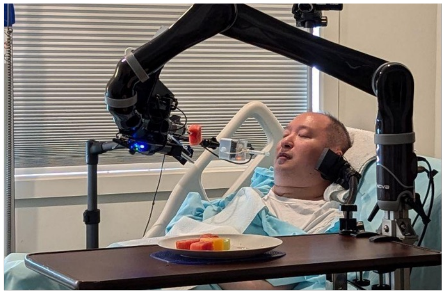
Context-dependent Robot Use

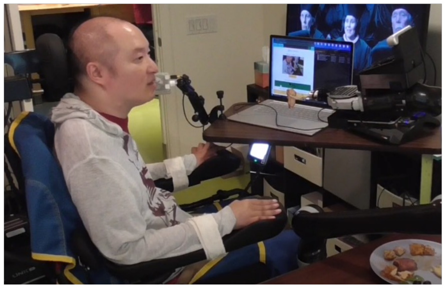
Food-dependent use:

"I wouldn't eat all my meals with it. Some foods I like [e.g., ramen] can be difficult for it. [But] I like pizza a lot; it did fine with pizza." (CR2)

Time-dependent use:

"[When I'm] eating for enjoyment, during dinner, [using the robot] is great. For breakfast and snack, where I feel I should be working, things are rushed." (CR2)





Lesson #3:

- Assistive robots integrate into a user’s life
- They provide contextual benefits
- They can still add value to users’ ADL toolkit

community researchers

occupational therapists

Lesson #4: Work with end-users & stakeholders

caregivers

"Sometimes people feed me, and I don't like how they're doing it. It's weirdly empowering, as someone who's been paralyzed as long as I have, to say, 'I'm going to eat this. It'll take me 3 times as long, but I'm not going to be frustrated while I eat."' (CR2)

Future Work

- Bite Acquisition:
  - Online failure prediction & recovery
  - More food types, e.g., ramen
- Bite Transfer:
  - Approaching below the eyeline
- Commercial Viability:
  - Reduce system cost (from $50K)
  - Make the case for insurance approval
- Integration into Care Routines:
  - Co-design setup & maintenance with caregivers

Roadmap

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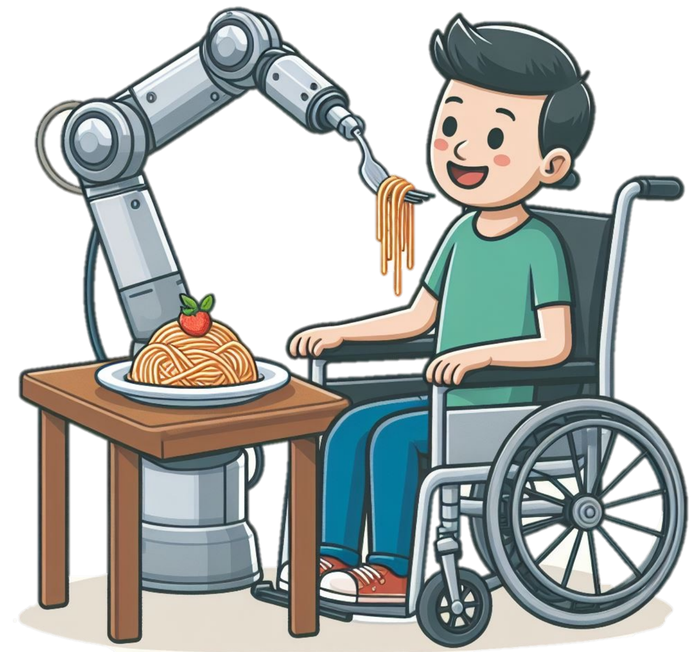
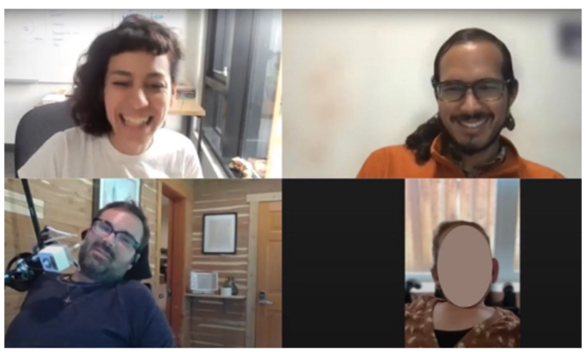


Media

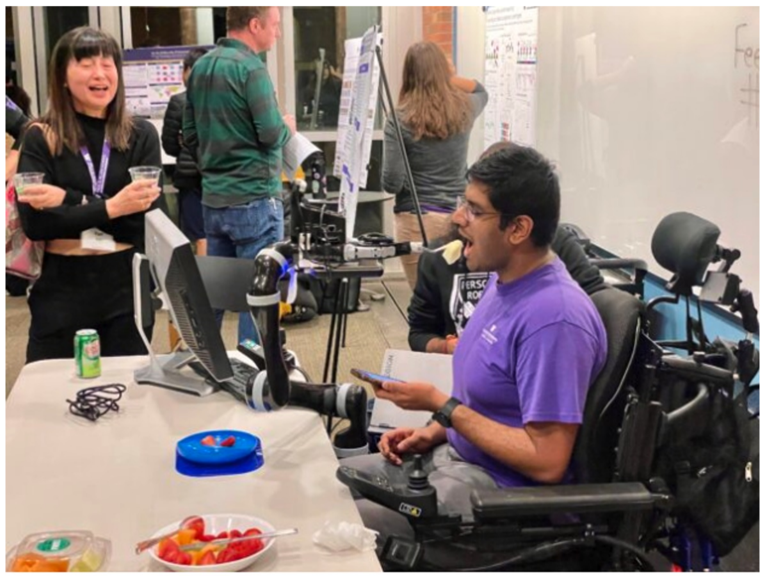
Setting the table for a brighter future: With help from robots, Allen School researchers are making social dining more accessible



GeekWire

UW computer science research event offers a glimpse of the future at the dawn of AI

BY TAYLOR SOPER & TODD BISHOP on November 15, 2023 at 10:31 am



University of Washington student Atharva Kashyap demonstrates a robot-assisted feeding system at the UW's computer science Open House event on Tuesday in Seattle. (GeekWire Photo / Taylor Soper)

November 16, 2023

Q&A: How an assistive-feeding robot went from picking up fruit salads to whole meals

Stefan Milne

UW News

A team led by researchers at the University of Washington created a set of 11 actions a robotic arm can make to pick up nearly any food attainable by fork. This allows the system to learn to pick up new foods during one meal. Here, the robot picks up fruit. *University of Washington*


November 22, 2022
Welcome to the first annual
Robot Assisted Feeding Retreat!
OCCUPANCY
LIMIT
26

Paying it Forward

Nanavati, Amal*, Vinitha Ranganeni*, and Maya Cakmak. "Physically assistive robots…" *Annual Review of Control, Robotics, and Autonomous Systems* (2023).

Nanavati, Amal*, Max Pascher* et al. "Multiple Ways of Working with Users…" *A3DE@HRI* (2024).

Kashif, Afifah, **Amal Nanavati**, and Maya Cakmak. "Insurance and Policy Considerations…" *To be submitted.*

robotfeeding.io/publications

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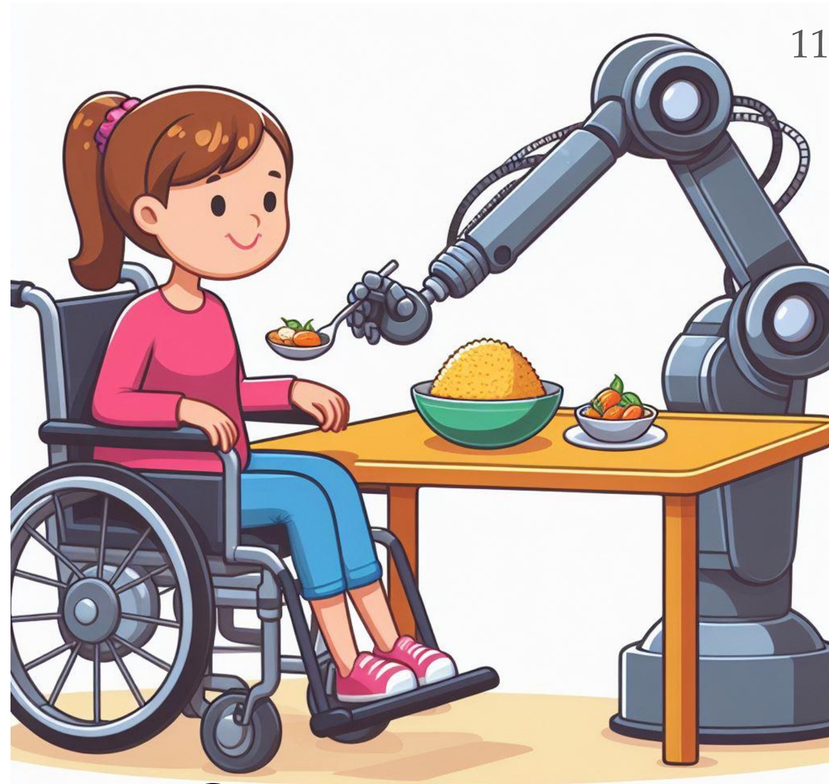
Vinitha Ranganeni
Atharva Kashyap
Sriram Kutty
Haya Bolotski
Nick Walker
Chris Mavrogiannis
Tapo Bhattacharjee
Leila Takayama
…and all labmates!

Committee

Anat Caspi
Henny Admoni
Kim Ingraham



Thank You
Any Questions?

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robotfeeding.io

NSF · curious minded machine · NIBIB · CREATE Center for Research and Education on Accessible Technology and Experiences UNIVERSITY of WASHINGTON · Office of Naval Research Science & Technology ONR · NIH National Institutes of Health · amazon · cobot · cruise · W UNIVERSITY of WASHINGTON