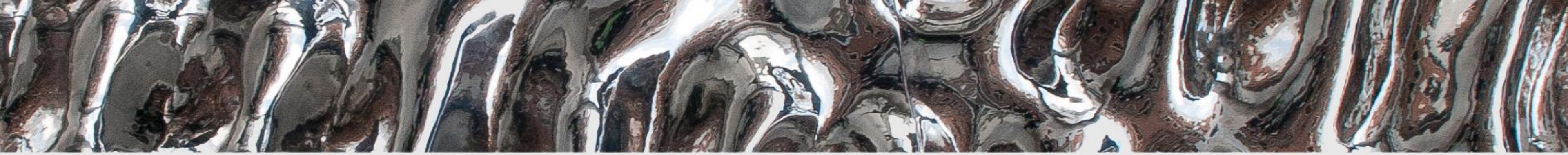


UiO : Department of Informatics
University of Oslo

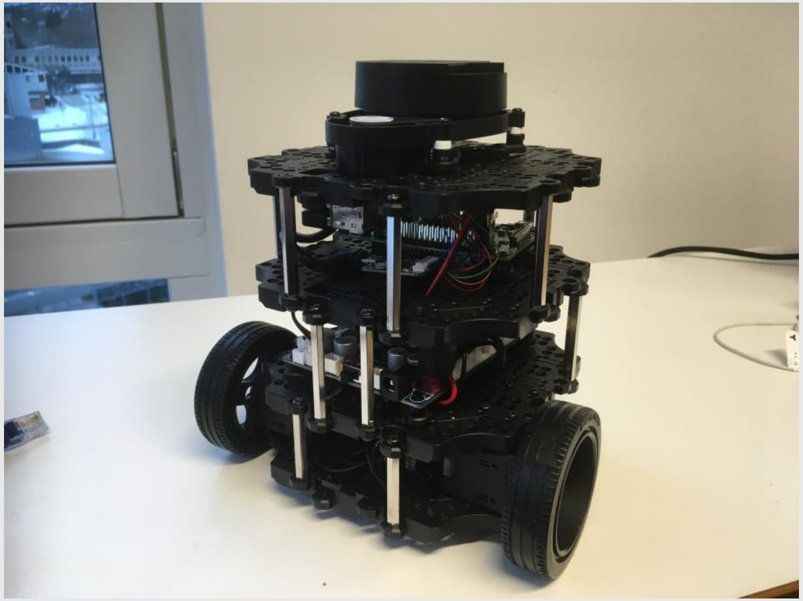
Robots and Movement

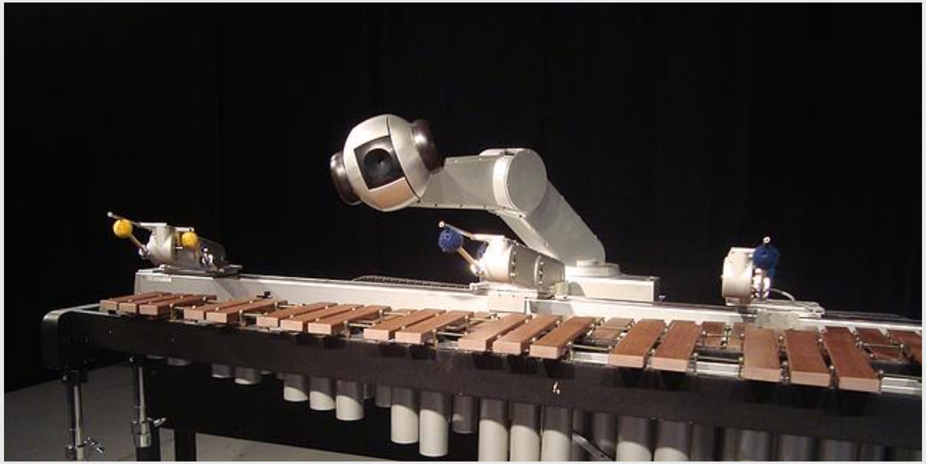
IN5480

1 September 2020

NR Norsk Regnesentral
NORWEGIAN COMPUTING CENTER

This lecture discusses robots, animation, & how they can be combined





Definition:

ROBOT

A robot is:

> “Actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks”
>
> —ISO 8373:2012

https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-2:v1:en

Or … a robot is:

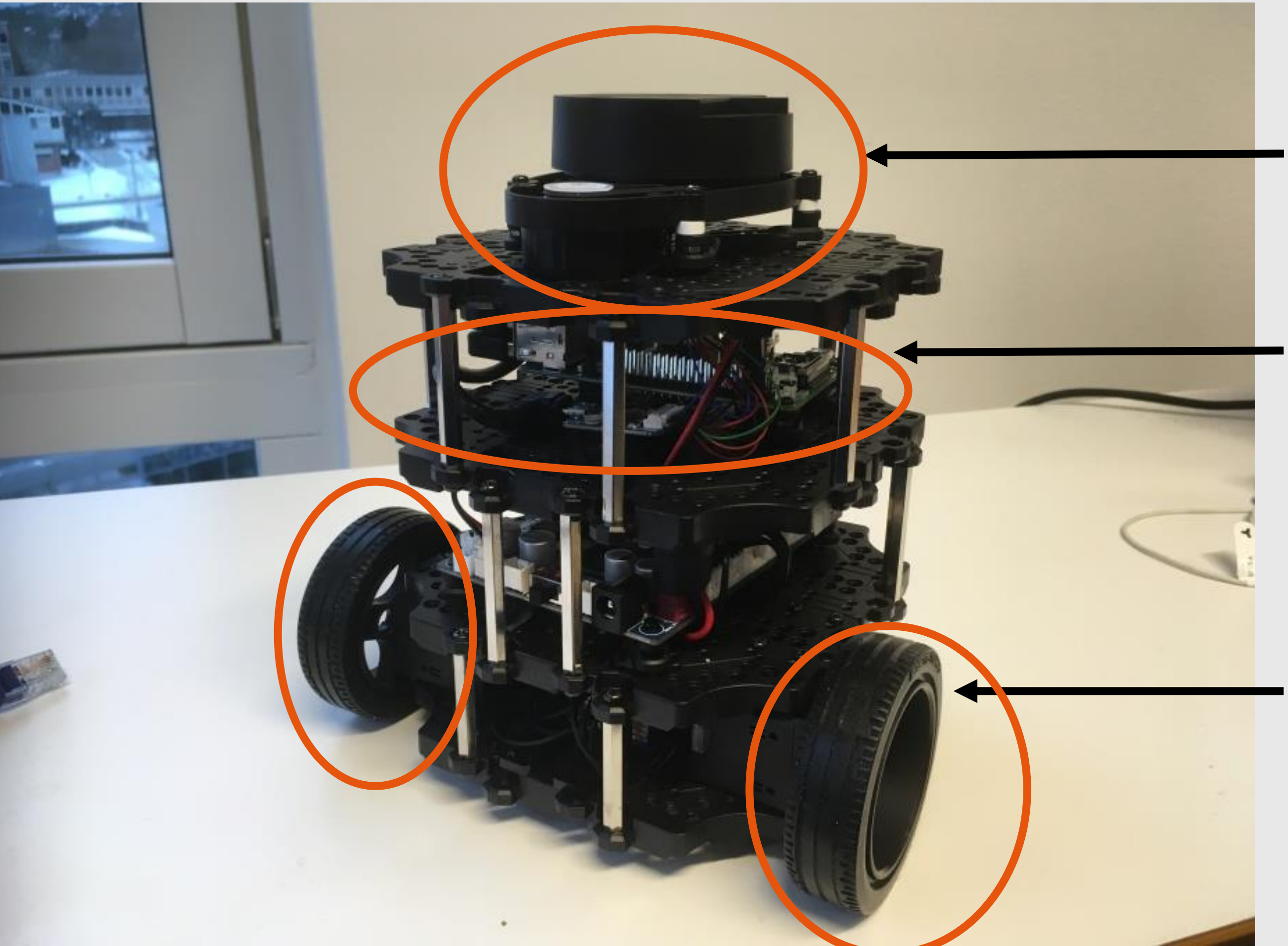
> “A robot … refers to a physical object that interacts with the physical environment, either on its own or via a person, to accomplish a task.”
>
> —Me
>
> *Exploration of Moving Things in the Home*
> http://urn.nb.no/URN:NBN:no-77171

The term *robot* is difficult to agree on

> ”We recommend that future investigations should consider the evolving nature of the concept of a robot in our global culture and perception of the term which is clearly varying across time.”
>
> —Kessler et al. (2017)

Kessler, T. T., Larios, C., Walker, T., Yerdon, V., & Hancock, P. A. (2017). A Comparison of Trust Measures in Human–Robot Interaction Scenarios. In P. Savage-Knepshield & J. Chen (Eds.), *Advances in Human Factors in Robots and Unmanned Systems* (Vol. 499, pp. 353–364). Springer International Publishing. https://doi.org/10.1007/978-3-319-41959-6_29

Robot's typically have three actions



Sense: Read data from sensors

Compute: Process data

Act: Do something based on the data

Human-Robot Interaction follows from an origin in teleoperation in factories, but has spread to other areas

1. Search and Rescue
2. Assistive and educational robotics
3. Entertainment
4. Military and police
5. Space exploration
6. Unmanned air vehicles

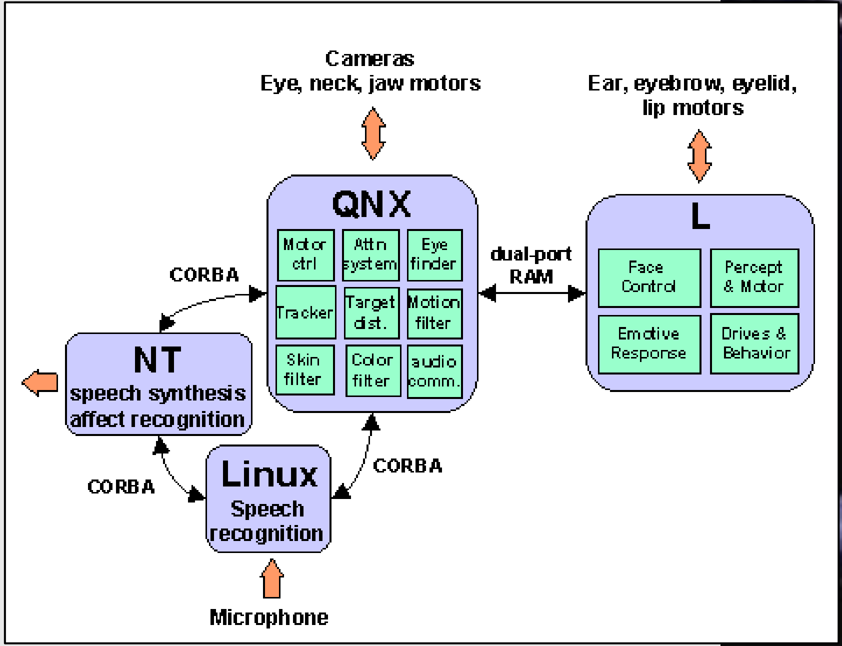
Robots can play different roles in an interaction

- Supervisor
- Operator
- Mechanic
- Peer
- Bystander
- Mentor

There are several best practices for doing HRI Research…

Including experts from multiple disciplines

Creating real systems



Cameras
Eye, neck, jaw motors

Ear, eyebrow, eyelid, lip motors

QNX
- Motor ctrl
- Attn system
- Eye finder
- Tracker
- Target dist.
- Motion filter
- Skin filter
- Color filter
- audio comm.

dual-port RAM

L
- Face Control
- Percept & Motor
- Emotive Response
- Drives & Behavior

CORBA

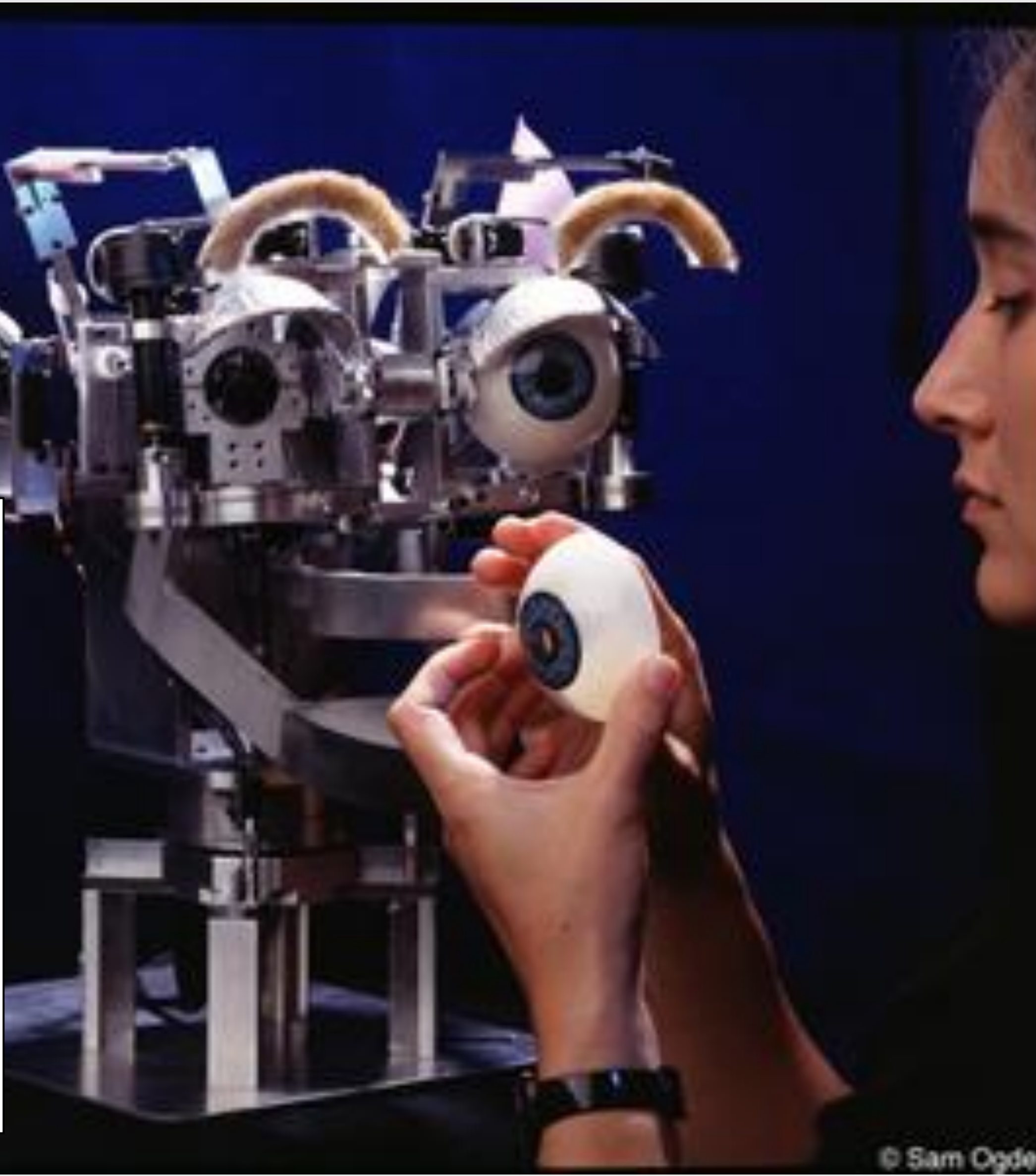
NT
speech synthesis
affect recognition

CORBA

Linux
Speech recognition

CORBA

Microphone



© Sam Ogde

Video is only available on the CD with the book (yes, a CD!)

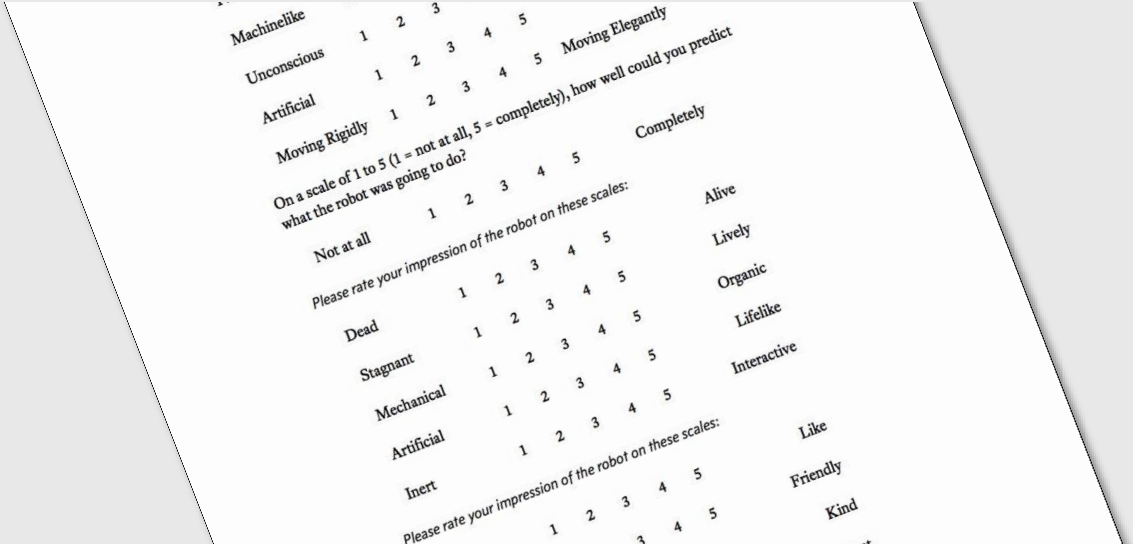
Breazeal, C. (2002). *Designing Sociable Robots*. MIT Press. https://mitpress.mit.edu/books/designing-sociable-robots

Conducting experiments blending simulation and physical robots

Establishing standards and common metrics

Godspeed series: http://www.bartneck.de/2008/03/11/the-godspeed-questionnaire-series/

Carpinella, C. M., Wyman, A. B., Perez, M. A., & Stroessner, S. J. (2017). The Robotic Social Attributes Scale (RoSAS): Development and Validation. *Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction*, 254–262. https://doi.org/10.1145/2909824.3020208



Machinelike
Unconscious 1 2 3
Artificial 1 2 3 4 5
Moving Rigidly 1 2 3 4 5 Moving Elegantly

On a scale of 1 to 5 (1 = not at all, 5 = completely), how well could you predict what the robot was going to do?

Not at all 1 2 3 4 5 Completely

Please rate your impression of the robot on these scales:

Dead 1 2 3 4 5 Alive
Stagnant 1 2 3 4 5 Lively
Mechanical 1 2 3 4 5 Organic
Artificial 1 2 3 4 5 Lifelike
Inert 1 2 3 4 5 Interactive

Please rate your impression of the robot on these scales:

1 2 3 4 5 Like
3 4 5 Friendly
Kind

Running Longitudinal Studies

Discussion

- How would you define the word “robot”?
- A podcast once had a debate over “is a machine gun a robot?” What do you think? Provide reasons for your decision. How does your definition above help support your decision?
- Is a drone a robot? Why or why not? How does your definition above help support your decision?
- What about chatbots or smart speakers?

I wrote a paper to map the landscape of using animation techniques with HRI

Animation Techniques in Human-Robot Interaction User Studies: A Systematic Literature Review

TRENTON SCHULZ, JIM TORRESEN, and JO HERSTAD, University of Oslo, Norway

There are many different ways a robot can move in Human-Robot Interaction. One way is to use techniques from film animation to instruct the robot to move. This article is a systematic literature review of human-robot trials, pilots, and evaluations that have applied techniques from animation to move a robot. Through 27 articles, we find that animation techniques improves an individual's interaction with robots, improving the individual's perception of qualities of a robot, understanding what a robot intends to do, and showing the robot's state or possible emotion. Animation techniques also help people relate to robots that do not resemble a human or robot. The studies in the articles show further areas for research, such as applying animation principles in other types of robots and situations, combining animation techniques with other modalities, and testing robots moving with animation techniques over the long term.

CCS Concepts: • **Computer systems organization** → **Robotic autonomy**; *Robotics*; • **Human-centered computing** → *HCI design and evaluation methods*; *Interaction paradigms*;

Additional Key Words and Phrases: Robot, human-robot interaction, literature review, animation, motion

ACM Reference format:
Trenton Schulz, Jim Torresen, and Jo Herstad. 2019. Animation Techniques in Human-Robot Interaction User Studies: A Systematic Literature Review. *ACM Trans. Hum.-Robot Interact.* 8, 2, Article 12 (May 2019), 22 pages.
https://doi.org/10.1145/3317325

12

1 INTRODUCTION

When the Kismet robot was introduced, individuals could interact with it via conversation or gestures as opposed to typing on a keyboard [18]. Human-robot interaction (HRI) requires the robot to also respond. A robot that gestures and moves can aid an individual in understanding hat the robot is doing and aid in the interaction.

ovie production, we observed the phenomenon of *animation*—layering slightly different n object to create the illusion of movement. Animators follow principles such that believable and tell stories [85]. The principles are successfully used in computer dies suggested that the principles should be considered for robots [68, 89]. ent to which animation techniques are used with robots and how do RI?

Norwegian Research Council under Grant No. 247697 of the IKT-
luss/Home_page/1254002053513).
ity of Oslo, Department of Informatics, Postbox 1072
ichel@ifi.uio.no.
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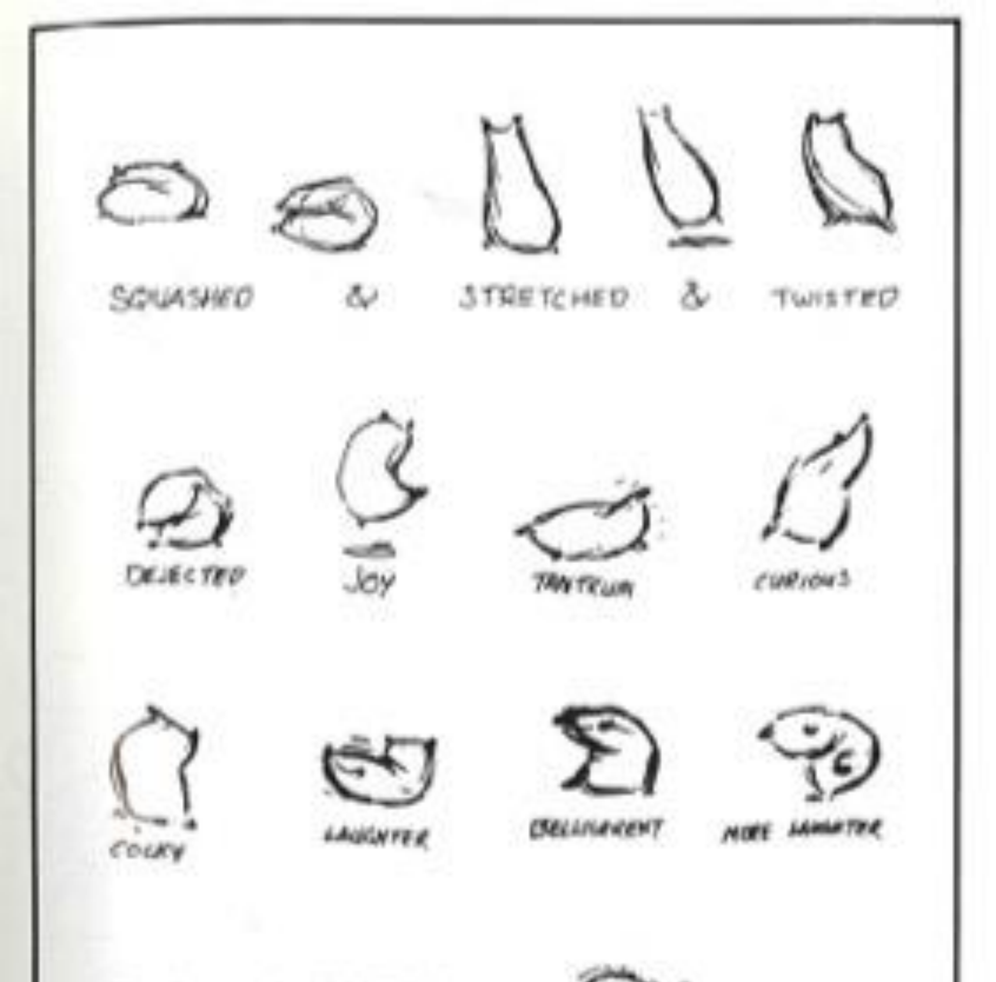
Thomas & Johnston documented the 12 Principles of Animation

1. Squash and Stretch
2. Anticipation
3. Staging
4. Straight Ahead Action and Pose to Pose
5. Follow Through and Overlapping Action
6. Slow In and Slow Out
7. Arcs
8. Secondary Action
9. Timing
10. Exaggeration
11. Solid Drawing
12. Appeal

Squash and stretch—objects should squash and stretch, but they should not lose their shape



Squash and stretch—objects should squash and stretch, but they should not lose their shape

https://youtu.be/JxmZyEH4IVI

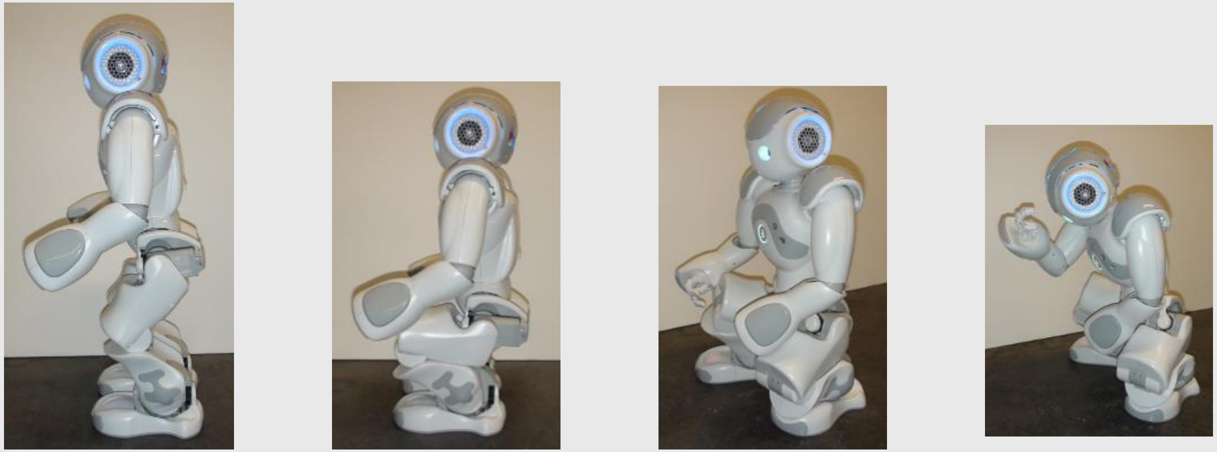
Anticipation—Major action should be telegraphed

Donald draws back with raised leg in anticipation of the dash he will make out of the scene.

Anticipation: Shimon grew a head for making it easier to collaborate with multiple musicians

https://youtu.be/jtC_CNPiGe8

Straight Ahead Action and Pose to Pose—Just have action happen or set up certain poses and interpolate between.



Follow Through and Overlapping Action—Actions are not performed in isolation; they lead into each other

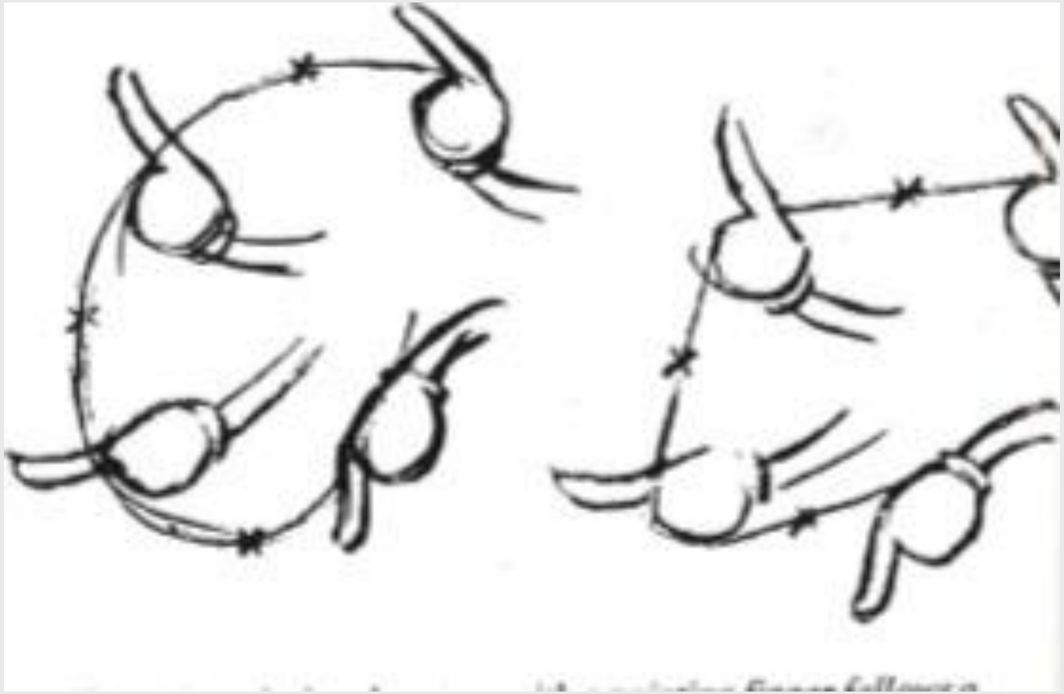
ANIMATOR: *Les Clark*—
Mickey's Grand Opera.

Squash and stretch have now been combined with follow through and overlapping action on the feather and other parts to give a feeling of weight and living form.

59

Slow In and Slow Out—Action is slower at the beginning and the end of an action

Arcs—Move limbs in arcs as opposed to of straight up-down and left-right motions



Exaggeration—Exaggerated motion makes it easier to read a character’s emotion

https://youtu.be/CL0qxUWekMU

Solid Drawing—Avoid twins: symmetrical limbs on a character

THIS IS WHAT'S CALLED A "WOODEN" CHARACTER.

EACH EYE, EAR, ARM, HAND, FINGER, LEG, COLLAR, SHOE, ETC. LOOKS THE SAME AS ITS COUNTERPART. THE RESULT IS A VERY STIFF LOOKING POSE.

...THIS CHARACTER LOOKS MORE NATURAL SIMPLY BECAUSE EACH PART OF THE BODY VARIES IN SOME WAY FROM THE CORRESPONDING OPPOSITE PART.

FINGERS THAT VARY GIVE THE HANDS A MORE DYNAMIC LOOK.

I’ll present a some work that I’ve done on animation techniques with robots

Classifying Human and Robot Movement at Home and Implementing Robot Movement Using the Slow In, Slow Out Animation Principle

Trenton Schulz, Jo Herstad, Jim Torresen
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0316 Oslo, Norway
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Abstract—We examine how robot movement can help human-robot interaction in the context of a robot helping retired people at home. Many people are not familiar with a robot moving in their home. We present four movement conditions to classify movement between a human and robot at home. Using phenomenology and familiarity, we recognize some of these conditions from other interactions people have with other moving things. Using techniques from animation in movies, we give the robot a distinctive style that can make the robot's movement more familiar and easier to understand. We examine animation further and present how to implement the animation principle of slow in, slow out with a research robot that can control its speed. We close the paper with future work on how to use the classification system and how to build on the slow in, slow out principle implementation for animated robots.

Keywords–human-robot interaction; animation; style; movement; slow in, slow out; familiarity; home;

I. INTRODUCTION

In previous work [1], we saw that projections for people over 60-years old not working (hereafter “the elderly”) will be larger than the number of people working [2]. As people age, they tend to accumulate different aches, pains, diseases, and disabilities. The elderly will need assistance to continue to live independently with these acquired health issues. For example, a robot with sensors can help monitor and assist the elderly person staying at home. The elderly and other people need to easily interact with the robots. Making the robot move distinctively using techniques from animation could make this interaction easier.

Previously, we used phenomenology to examine movement [1] and classified robot movement into classes. We also discussed robot movements in the frame of proxemics [3], people’s familiarity with robot movement, and animation techniques that could help make the movement more familiar. In this paper, we build on the previous work [1] by further exploring the topics of familiarity and proxemics, before introducing a formalized version of robot movement and a possible way to animate it using a classic animation principle of *slow in, slow out*. Combining the phenomenological and the formalized exploration of robot movement and animation gives us a starting point for building future work on human-robot interaction (HRI).

To accomplish this, we first present the context f
amining robot’s movement in the home (Sectio
we discuss robot movement and what a
means for robots and HRI (Section
look at robots and human mo
for classifying moveme

robot (Section IV). We use this framework to aid in looking at the concept of familiarity and how robot motion compares to motion of other objects people encounter in everyday life (Section V) and how animation can help with this familiarity. Then, we present a formalized version of robot movement and how to derive slow in, slow out movement from it (Section VI). Finally, we present ideas for future work (Section VII) before concluding the article (Section VIII).

II. RESEARCH CONTEXT: ROBOTS AT HOME

Western countries are examining the issue of the “elderly wave” [2]: the number of people who will be retiring and needing care will be larger than the people entering the workforce for these jobs. To cut down on the demand for care, some countries have set goals that more elderly should live independently at home longer. One way of addressing this goal is to turn to *welfare technology* that can assist the elderly [4]. Some new technology includes the Internet of Things and smart home sensors for reporting and helping elderly complete tasks [5][6]. Sensors can also provide a warning when things go wrong, such as an elderly person falling [7].

Instead of mounting the sensors all over in the house, we can mount the sensors on robots. Robots are mobile and can be customized for handling different tasks. Robots are already in the home: domestic robots cut the lawn and vacuum carpets, and other robots provide entertainment (the robot dog Aibo [8]) or stress relief (the Paro seal [9]).

A. Projects Looking at Elderly and Robots

Several other projects have looked at having robots help the
elderly. One example is Care-o-bot [10], [11] that can assist in
multiple tasks for the elderly at home. The Paro seal robot h
been used to look at how elderly and people with d
react to a robot in a nursing home context [12
have investigated how elderly interact w
looked at a robot that interacted
situations and during card g

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that investig
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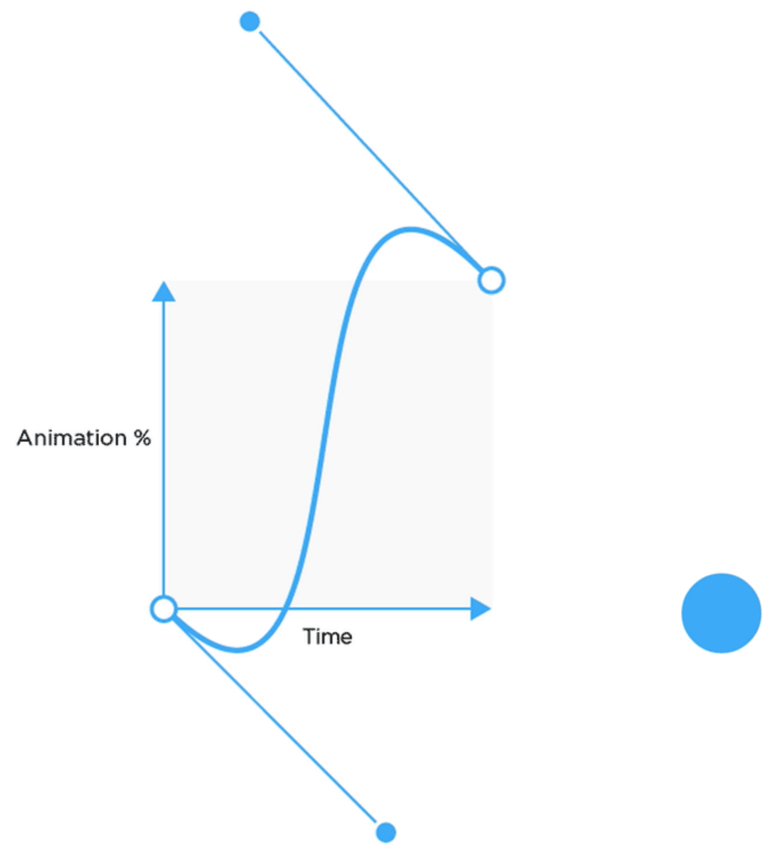
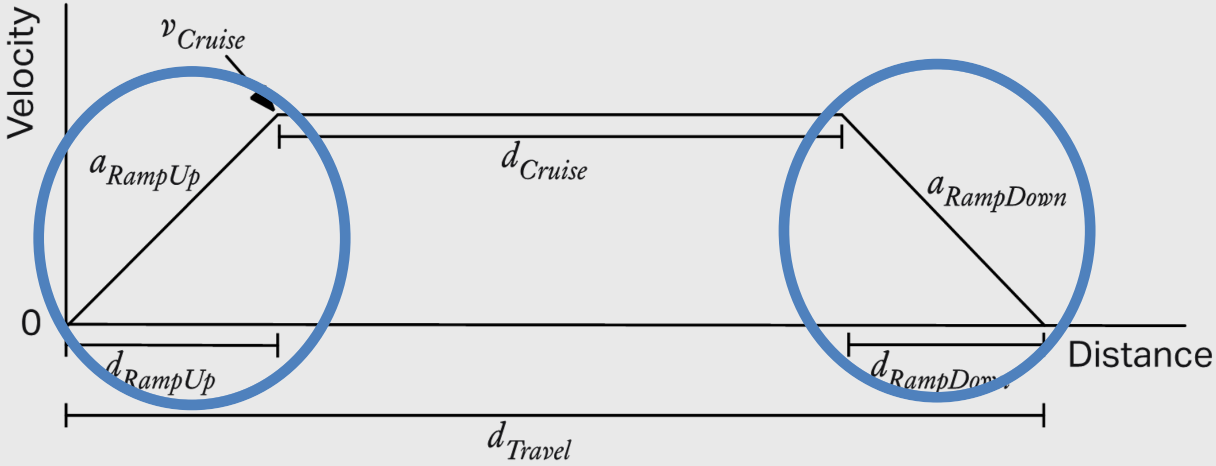
We can classify movement between robot and human in 4 conditions

Condition	Human	Robot
1	Local	Local
2	Local	Global
3	Global	Local
4	Global	Global

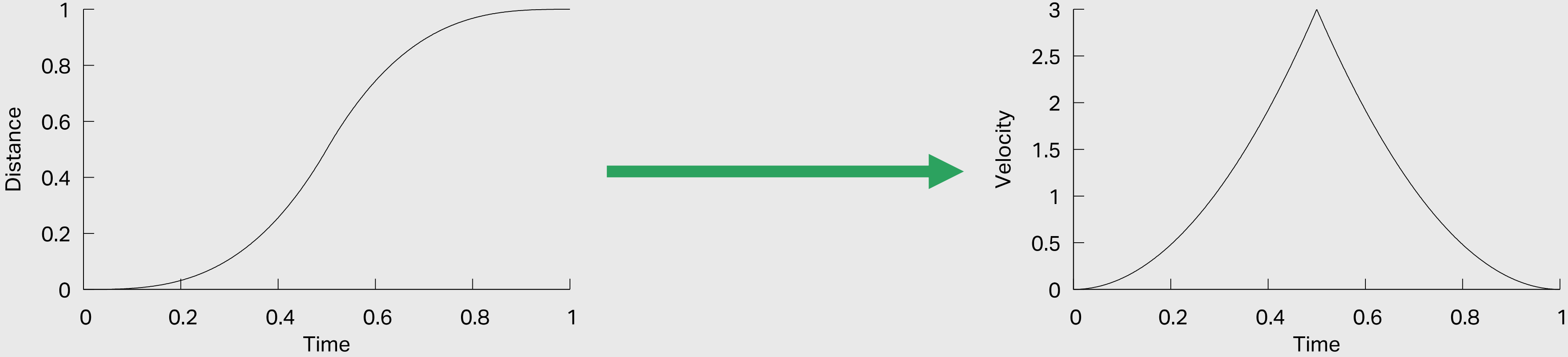
Slow in and slow out uses easing curves to specify *movement*, but robots control their *speed*, not their movement



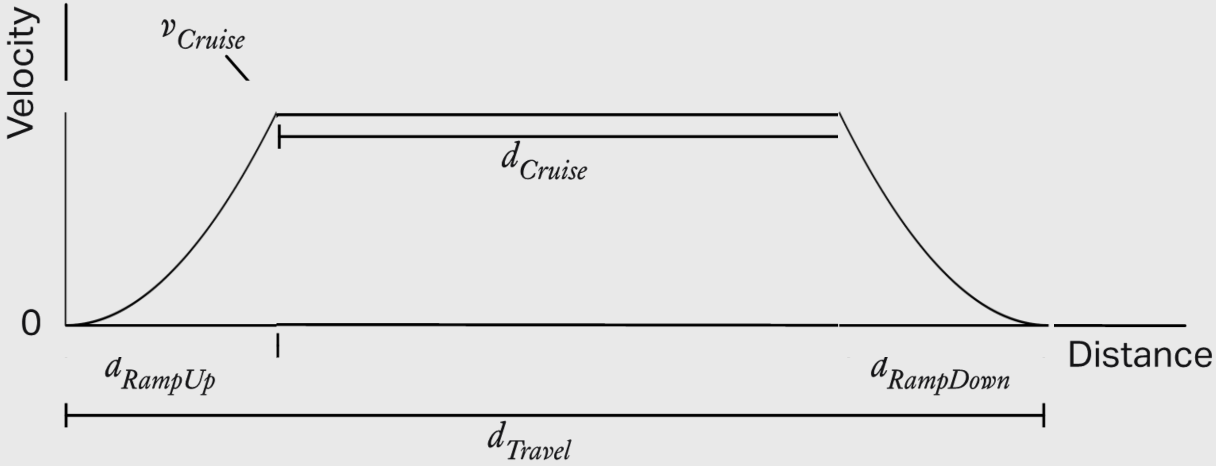
Robots movement can be graphed as a velocity profile of velocity over distance



Using Calculus, we can take the derivative of an easing curve and use it to get the velocity



Applying the derived velocity curves results in a slow in and slow out appearance



Discussion: How can one test a robot using an animation principle with people? Which animation principle would you like to explore more?

https://youtu.be/4RZn15EdMbo