HRI Reading Group

@ Instituto Superior Técnico

Spring 2019

Meeting #6 (29 Mar 2019)

Paper

Phillips, Elizabeth, Xuan Zhao, Daniel Ullman, and Bertram F. Malle. **"What is human-like?: Decomposing robots' human-like appearance using the anthropomorphic robot (abot) database."** In *Proceedings of the 2018 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 105-113. ACM, 2018.

Anthropomorphic Appearance as a Cornerstone of HRI Research

Positive Effects of using Humanoid Robots

1. The psychological effects of robot appearance on human perceivers is a widely studied research topic in the field of human-robot interaction
2. Numerous studies have demonstrated that a robot's appearance may considerably influence people's perceptions of its intelligence, sociability, likability, credibility, and submissiveness, among other characteristics and traits.
3. Robots that modeled after humans have been shown to be particularly influential.
    a. People experienced more fun interacting with increasingly humanlike robotic partners,
    b. Users preferred a healthcare robot that displayed a human face over one without a human face.
    c. When a robot appears more human-like, people are more likely to take advice from the robot, take the robot's visual perspective, empathize with the robot, and even expect the robot to make moral decisions that are similar to those made by humans .
    d. Robots that resemble humans provide people with a sense of familiarity, which may ease social acceptance

Anthropomorphic Appearance as a Cornerstone of HRI Research

Risks associated with robots' human-like appearance.

a. Highly anthropomorphic robots may lead people to form expectations about capabilities that robots might not fulfill .
b. When those expectations are violated, people may lower their assessments of the robot [25], discontinue relying on the robot [19], and, in some cases, stop interacting with the robot altogether [9].
c. The "Uncanny Valley" hypothesis suggests that a robot's imperfect human-likeness can evoke eerie feelings in human perceivers [5, 22, 24, 32].
d. Other researchers have proposed that robots with a high degree of human-likeness may blur the human-robot boundary and undermine human uniqueness, leading people to perceive robots as a threat [15].

Need for Systematic Approach and Standardised Measures

1. Human-likeness in robots is undoubtedly powerful and requires careful assessment and consideration.

    a. Necessary to develop a systematic understanding of robots with human-like appearance.

What are the features that make up anthropomorphic robots?

Can these features be organized into a smaller number of underlying dimensions?

And which features most strongly predict robots' perceived degree of human-likeness?

Need for Systematic Approach and Standardised Measures

Researchers and designers are typically forced to rely on heuristics and intuitions when selecting human-like robots to include in studies or manipulating human-like features in robot design. This approach has suffered from several problems.

Need for Systematic Approach and Standardised Measures

1. A quantitative system to describe the degree of human-likeness in different robots is currently lacking, comparing research findings across studies has been challenging. the most common grouping based on their appearances, such as mechanical, humanoid, or android

2. When researchers assess people’s impressions of a robot’s appearance quantitatively, they typically treat the concept of “human-likeness” as unidimensional.

Need for Systematic Approach and Standardised Measures

1. When studying the effects of robot appearance, researchers have tended to limit themselves to robots that are either commercially successful (e.g., Nao, Robovie) or conveniently available to specific research groups (e.g., Kismet, Pearl).

2. Relying on only a few robots is likely a result of practical limitations, these practices could lead researchers to ignore the wide variety of extant robots and the nuanced differences in their appearances.

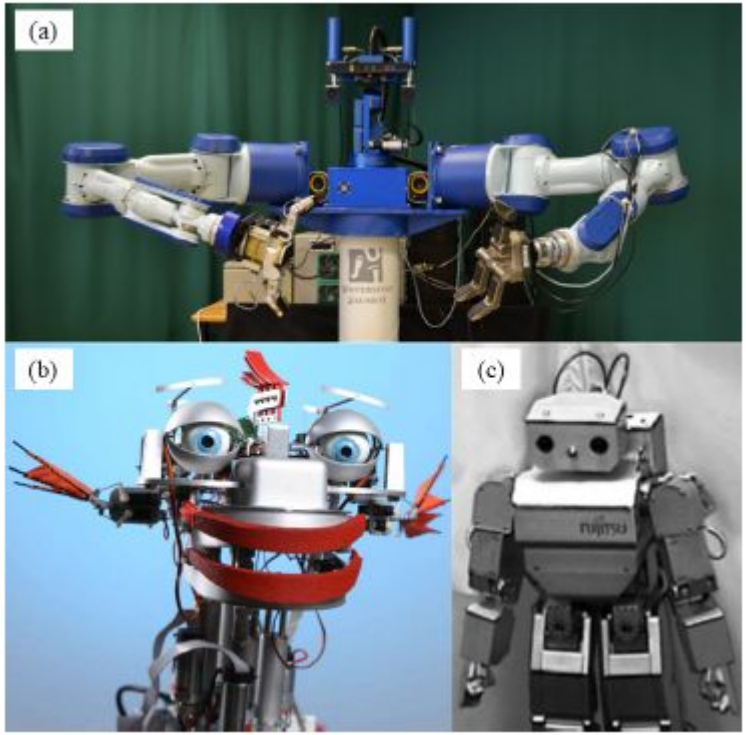
3. Conclusions about the psychological effects of human-likeness may therefore not be generalizable to a more diverse collection of anthropomorphic robots.

Need for Systematic Approach and Standardised Measures

Robots that share the same label across different studies may actually differ dramatically in their degree of human-likeness.

Each of them was chosen as the “prototype” humanoid robot in their respective studies, yet it is unclear whether human perceivers would actually consider them to be equally human-like.

A precise metric is therefore needed to compare different robots on a common scale and allow researchers to replicate findings with robots of equivalent human-likeness.

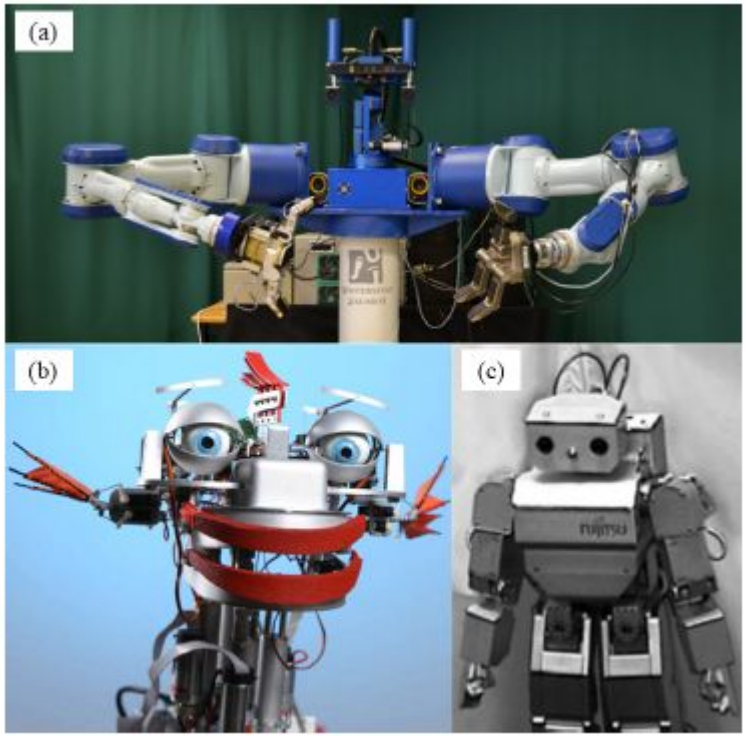


Need for Systematic Approach and Standardised Measures

Human-likeness may present itself through different features.

The robot has a head with exposed mechanics and no specific face contour, yet it has arms and hands; consists of only a head with detailed human-like eyes, eyebrows, and a prominent mouth, yet exposed actuators without a smooth contour; has a clearly defined box-shaped head, a face with dark circles representing its eyes, a pointed structure representing its nose, two arms, and two hands with five fingers each.

Each of these robots has been shown to create distinct psychological effects on human perceivers.



The ABOT DATABASE & Website

1. It provides a survey of the broad landscape of anthropomorphic robots—indeed, the largest repository of robots with human-like features to date.

2. The ABOT Database provides standardized images of robots and an expanding dataset of people's perceptions of these robots, both publicly accessible for future research.

3. The research using the ABOT Database will help deepen our understanding of what makes a robot look human.

Two empirical studies were on the basis of the documentation and validation of the ABOT Database.

Study 1

Goals

1. Document the human-like features present across anthropomorphic robots
2. Use these data to identify underlying relationships among the features

Method

1,140 laypeople (low experience with robots) were asked to judge the presence or absence of 19 appearance features across robots in the ABOT Database.

These appearance features derived from a previous coding scheme by Ezer (2008) and included both human-like and non-human like features.

- Participants were asked to judge whether a given features were present in each of the robots (by clicking “yes” or “no”)

- Participants were asked the same task in relation to images of humans and smart home devices (e.g., Alexa) - this served as a checking tool for confused or careless raters.

Table 1: Collection of appearance features and associated definitions in Study 1.

Feature:	Definition
Apparel:	Materials worn temporarily to cover the body.
Arm:	Upper limb typically used for manipulating objects.
Eye:	A round or oval shaped form that often gathers visual information.
Eyebrow:	A line above the eye usually consisting of hair.
Eyelashes:	Threadlike filaments that surround the eyelid.
Face:	The front part of the head, which may contain features such as eyes, nose, or mouth.
Finger:	Each of a number of slender jointed parts connected to the hand.
Genderedness:	Features of appearance that can indicate biological sex, or the social categories of being male or female.
Gripper:	The claw-like terminal part of an appendage used for grasping and manipulating objects. (A claw-like gripper is not a hand).
Hand:	The terminal part of an arm, typically connected to the arm by a wrist. A hand is normally used for grasping, manipulating, or gesturing. (A claw-like gripper is not a hand).
Head:	The uppermost part of a body, typically connected to the torso by a neck. The head may contain facial features such as the mouth, eyes, or nose.
Head hair:	A collection of threadlike filaments on the head.
Leg:	Lower limb used for movement over ground.
Mouth:	A large opening located on the lower part of the face.
Nose:	A projected feature of the face above the mouth.
Skin:	A thin layer of tissue covering almost the entire body.
Torso:	The trunk or middle part of the body (minus the limbs and head).
Treads/Tracks:	Moving bands that transport things like tanks over rough terrain. They are sometimes called tank treads or caterpillar treads.
Wheel:	A round device that rolls on the ground and transports an entity over surfaces.

Results

Table 2: Principal Components Loading Matrix, Study 1.

Feature	PC 1 Surface	PC 2 Body	PC 3 Facial	PC 4 Mech.
1. Eyelashes	**.88**	-.08	.15	-.04
2. Headhair	**.85**	.05	.03	-.06
3. Skin	**.83**	.07	.07	-.13
4. Genderedness	**.80**	.28	.17	-.12
5. Nose	**.71**	.05	.33	-.05
6. Eyebrows	**.69**	-.19	.38	.02
7. Apparel	**.68**	.28	.07	-.13
8. Hands	.12	**.93**	.06	.02
9. Arms	.02	**.92**	.10	.01
10. Torso	.07	**.90**	.19	.07
11. Fingers	.14	**.86**	.02	.05
12. Legs	-.06	**.74**	-.08	-.23
13. Face	.28	.14	**.90**	.02
14. Eyes	.14	-.02	**.88**	-.01
15. Head	.13	.49	**.73**	.03
16. Mouth	.48	.05	**.57**	-.07
17. Wheels	-.13	-.09	.01	**.92**
18. Treads/Tracks	-.18	.06	-.01	**.91**
Eigenvalue	4.67	4.30	2.81	1.79
% Variance	25.93	23.88	15.62	9.93
Subscale Cronbach's α	.89	.93	.83	.82

Note: **PC 1**: Surface Look, **PC 2**: Body-Manipulators, **PC 3**: Facial Features, **PC 4**: Mechanical Locomotion. Subscales derived from features with loadings in bold.

DIMENSIONS

Surface look

body manipulators

Facial features

Mechanical locomotion

Study 2

Goal

Predict robots' perceived human-likeness from the presence of specific appearance features.

Method

98 participants assessed how human-like robots were with a slider, ranging from "Not human-like at all" (score 0) to "Just like a human" (score 100).

Results

Specific individual appearance features (especially torso, genderedness, and skin) or the underlying four appearance dimensions (especially Body-Manipulators and Surface Look) are good human-like predictors.

Good predictive power of the features lead to the development of an “Human-Likeness Estimator”

This estimator serves to approximate how human-like a robot will be perceived by laypeople based on the presence or absence of its appearance features.

Contributions

Discussion

Strong points of this work:

- Provides a systematic investigation of robots' human-likeness based on physical features
  - This enables the comparison of results using different robots but with similar human-likeness (measured by this tool). This will help create theories in HRI.
  - Human-likeness was never quantified before.
  - The database presents different robots that are not so mainstream.
- Good use-case of the usage of images of robots and online studies. There is no need for into the wild or lab studies using autonomous robots or WoZ approaches.

Discussion

What is missing in this work:

- Is human-like just in the physical appearance of the robot?
- How can human-like behavior, intentions, beliefs, be quantified?

Group Exercise

Think about a case-study to use this tool. *(As a predictor what it offers.)*

Is it possible to use this tool in your research.

Beyond physical:

Discuss at least 5 psychological features to differentiate anthropomorphic robots (and how they can be incorporated in a similar tool or quantified).

1- facial expressions; 2- speech intonation; 3) personality.

Dimensions: emotional, cultural, social.

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Meeting #7 (5 March 2019)