Proceedings of the First Conference on
Designing with Artificial Intelligence
dai digital 2020

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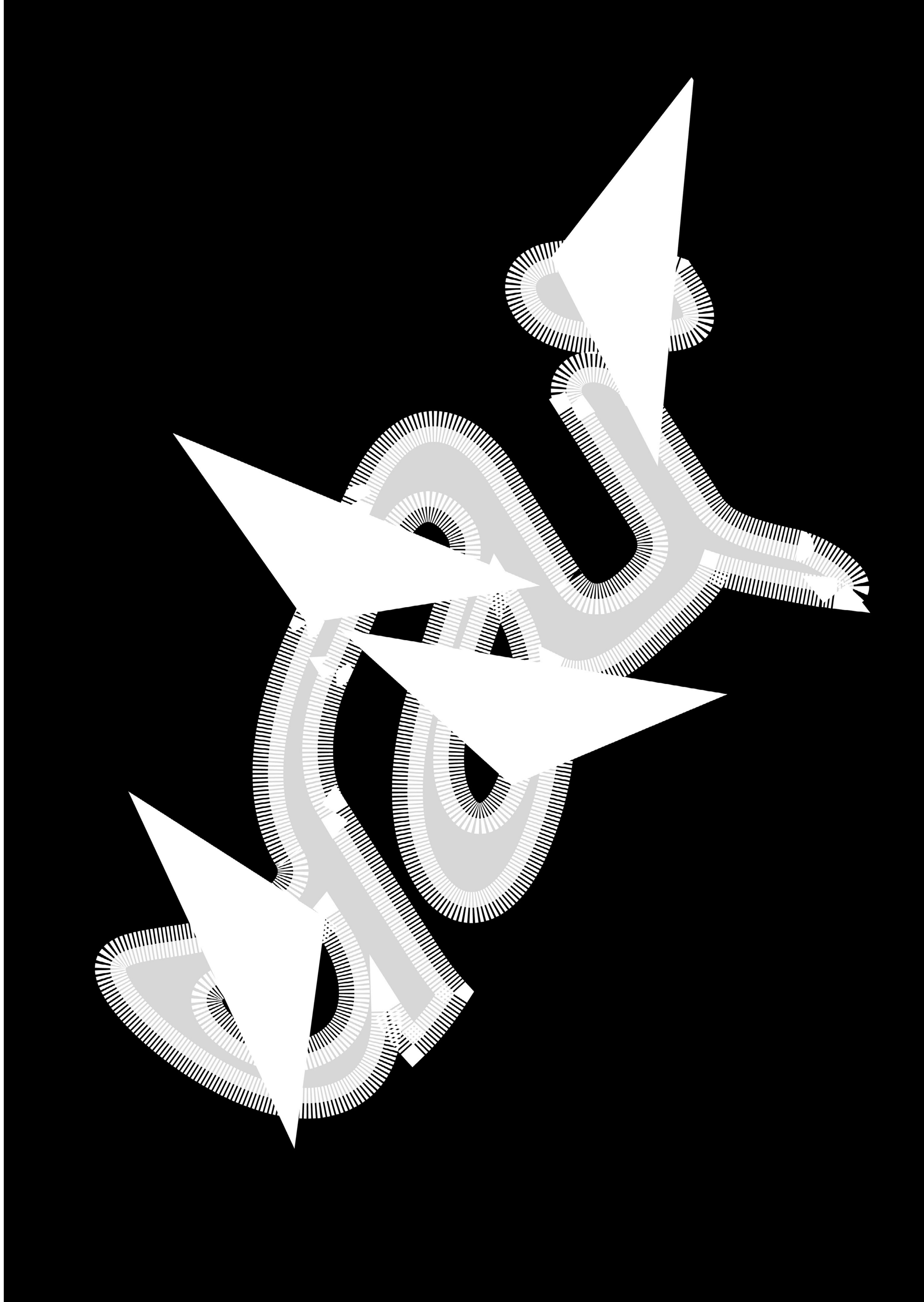

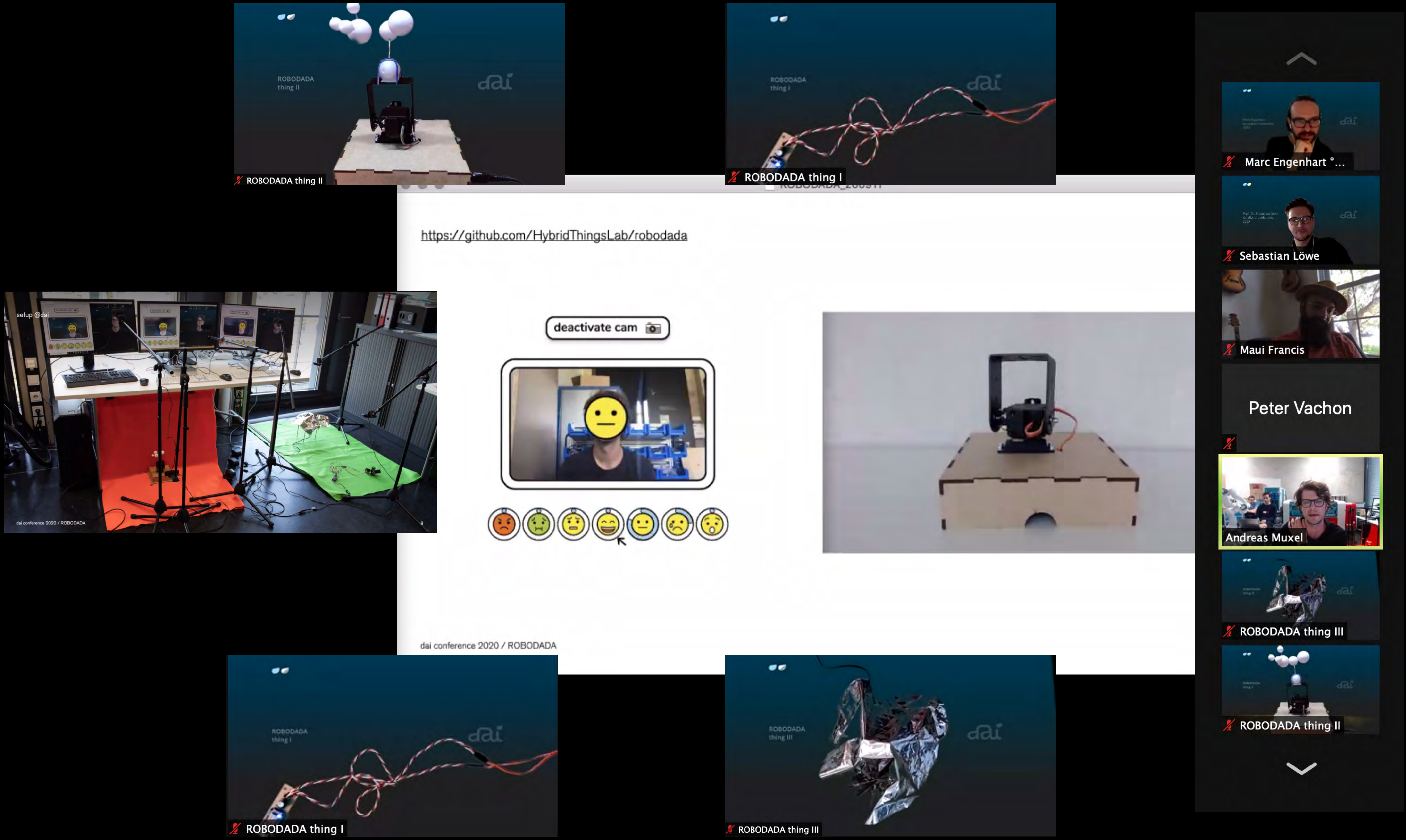

ROBODADA special release, presentation
September 18, 2020

ROBODADA: Speed-Dating with (Un)Friendly Robots

Andreas Muxel, Elias Naphausen

Practise

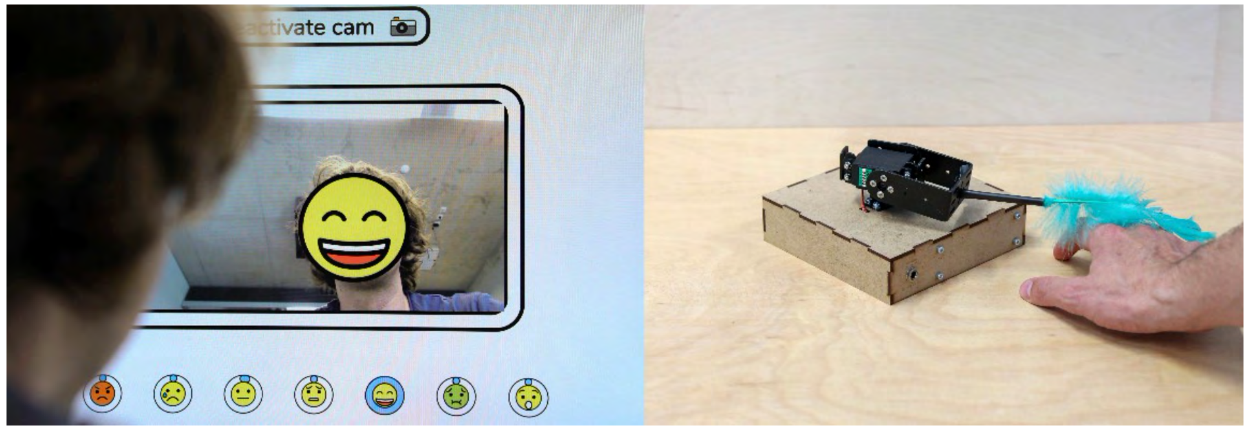

Figure 1: ROBODADA interface and installation view.

ABSTRACT

Robots are no longer just "better" or more "efficient" workers in factory halls, they also become co-actors in our daily lives, for example autonomous vacuum cleaners, chatty voice assistants or care robots. Sharing our home with these domestic automata we almost attribute human characteristics, emotions and aliveness to our technical counterparts, but we have to accept that the rational machine differs from us. Teaching interaction design, we ask how future technology might be shaped if machines evolve from trivial tools to technological associates. What does interaction with proactive technology mean for designing artifacts and its behavior? Design disciplines are highly dependent on computer sciences itself and are often not able to comprehensively demonstrate and explore topics of human-robot interaction. A technical and methodical toolbox is intended to overcome obstacles and facilitate access. ROBODADA is an open-source toolkit to map facial expressions to the body language of a robot. By adapting appearance and kinetic behavior, different aspects of interaction with emotion-aware robots can be explored playfully.

1. INTRODUCTION

Robotic objects are manifestations of our rational thinking in a mechanistic worldview. A robot can sense its environment (input), compute decisions based on the sensory information (algorithm) and act on these decisions through mechanical or electronic means (output) [1] .These input-output systems create repeatability, efficiency, power and control—robots follow the idea of functional and efficient tools. With the advent of proactive machines, our understanding of control changes the notion of interaction with our technical counterpart. Robots start to anticipate us, learn from us and interact with us. In these moments, they become "others" with which we have to find a way of dealing, and our relations to our technical counterpart changes.

Matthias Laschke and others describe these technologies as "otherware"[2] referring to AI-powered systems like smart voice

interfaces (e.g. Amazon's Alexa or Apple's Siri), robotic vacuum cleaners or even social robots. Otherware is not understood as a tool in the sense of a technical extension and enhancement, but rather as a counterpart that cooperates with us and shapes individual experiences. We discovered that users often imitate human-to-human behavioral patterns during the interaction with these machines. For instance, users follow established social norms, such as saying "thank you" and "please" when interacting with voice assistants.[3] Only a few social cues, like interactivity, language or human-like appearance are needed for the users to act this way[4]. It is assumed that this effect equally applies to the interaction with social robots[5] and we see a shift in human perception from functional tools to social entities. Therefore, we have to rethink traditional interaction mechanics like pressing a switch or turning a knob to communicate with these systems, because otherware becomes proactive, confronting us actively.

But how can a robot anticipate us and detect our intentions? According to Rosalind Picard[6], if we want machines to be smart and to interact almost naturally with us, one strategy can be to give them the ability to recognize and interpret our emotions. Affective computing describes the study and development of machines that can recognize and process human affects. The intent is to detect emotional states, for example looking at faces and knowing how people feel. The detection of faces within an image and the classification of facial expressions can be done with the help of machine learning algorithms[7]. But we should not be naive and think that our emotions can be extracted from a limited number of facial expressions, because the relationship between expressions and emotion is very complex[8]. Therefore, we have to explore and understand these technologies to identify potentials, but also critically discuss biases of such systems[9].

Furthermore, it seems to be reasonable to rethink affordances of the robotic others. In particular, how to shape physical appearance and behavior to support a dialog between human and machine. Motion and body language might be the main channel for a dialogue between robot and human, rather than any specific detail of the appearance[10]. Hagen Lehmann and others experimentally indicate that motion, even if it is not socially engaging behavior, increases the propensity of humans to ascribe intentions to robotic objects[11]. In another study, Christoph Bartneck and others suggested that for the perception of a robot's aliveness the behavior is more important than its embodiment[12]. Its perceived aliveness or animacy describes the extent to which "the robot is perceived as a life-like being"[13]. Furthermore, the perception of animacy determines how users interact with robots. Even a non-anthropomorphic machine elicits the perception of a social entity. This perceived agency of a robot plays a role in users' treatment of the robot, similar to humans dealing with living things[14]. One design strategy is to create otherware that resembles human beings (anthropomorphism) or animals (zoomorphism), but our assertion is, that robotic otherware is different. Robots are neither humans nor animals and they are not alive[15]. We have to think of a third category, exploring an alternative approach beyond the imitation of existing lifeforms.

1 Auger, J. (2014). Living with robots: A speculative design approach. Journal of Human-Robot Interaction, 3(1), 20-42.

2 Laschke, M., Neuhaus, R., Dörrenbächer, J., Hassenzahl, M., et al. (2020, October). Otherware needs Otherness: Understanding and Designing Artificial Counterparts. In Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society (pp. 1-4).

3 Lopatovska, I., & Williams, H. (2018, March). Personification of the Amazon Alexa: BFF or a mindless companion. In Proceedings of the 2018 Conference on Human Information Interaction & Retrieval, 265-268.

4 Nass, C., & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. Journal of social issues, 56(1), 81-103.

5 Bartneck, C., Van Der Hoek, M., Mubin, O., & Al Mahmud, A. (2007, March). "Daisy, daisy, give me your answer do!" switching off a robot. In 2007 2nd ACM/IEEE International Conference on Human-Robot Interaction (HRI) (pp. 217-222). IEEE.

6 Picard, R. W. (2000). Affective computing. MIT Press.

7 Mühler, V. (2019). face-api.js: JavaScript API for face detection and face recognition in the browser and node.js with tensorflow.org.js. https://towardsdatascience.com/face-recognition-using-javascript-api-face-api-js-75af10bc3dee.

8 Barrett, L. F., Adolphs, R., Marsella, S., Martinez, A. M., & Pollak, S. D. (2019). Emotional expressions reconsidered: Challenges to inferring emotion from human facial movements. Psychological science in the public interest, 20(1), 1-68.

9 Howard, A., & Borenstein, J. (2018). The ugly truth about ourselves and our robot creations: the problem of bias and social inequity. Science and engineering ethics, 24(5), 1521-1536.

10 Vidal, D. (2007). Anthropomorphism or Sub-Anthropomorphism? an Anthropological Approach to Gods and Robots. Journal of the Royal Anthropological Institute, 13(4), 917-933.

11 Lehmann, H., Saez-Pons, J., Syrdal, D. S., & Dautenhahn, K. (2015). In Good Company? Perception of Movement Synchrony of a Non-Anthropomorphic Robot. PloS one, 10(5), e0127747.

12 Bartneck, C., Kanda, T., Mubin, O., & Al Mahmud, A. (2009). Does the Design of a Robot Influence Its Animacy and Perceived Intelligence? International Journal of Social Robotics, 1(2), 195-204.

13 Horstmann, A. C., Bock, N., Linhuber, E., Szczuka, J. M., Straßmann, C., & Krämer, N. C. (2018). Do a robot's social skills and its objection discourage interactants from switching the robot off?. PloS one, 13(7), e0201581.

14 Hoenen, M., Lübke, K. T., & Pause, B. M. (2016). Non-anthropomorphic robots as social entities on a neurophysiological level. Computers in Human Behavior, 57, 182-186.

15 Johnson, D.G., Verdicchio, M. (2018). Why Robots Should Not Be Treated Like Animals. Ethics and Information Technology 20, 291–301.

2. ROBODADA

ROBODADA is an open-source toolkit that facilitates mapping facial expressions to movements of a robot. Via a web interface users can assign two-dimensional motion paths to a pan-and-tilt robot. These pre-defined motions are then activated by a face recognition algorithm. The algorithm tracks the users' basic emotions[16] over the users' webcam, which subsequently triggers the robot's pre-recorded motions.

2.1 Why?

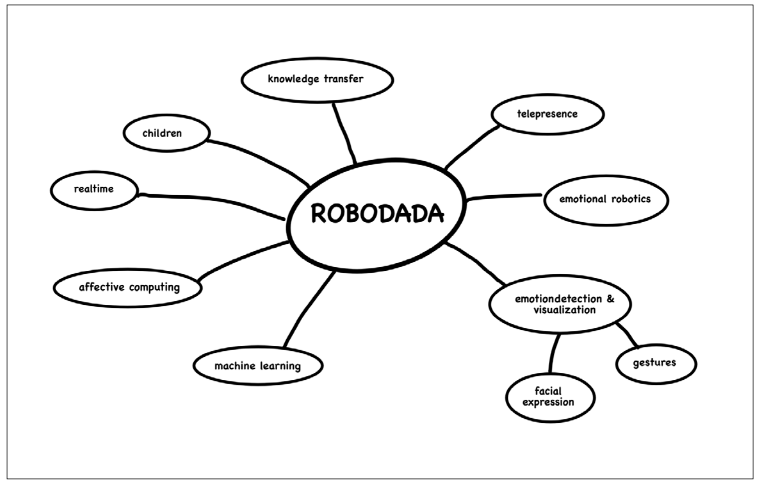

Figure 2: Topics of ROBODADA.

As the relationship between man and machine changes and algorithms progress by mimicking intelligence, we see a need to address a broader audience to show and discuss topics like affective computing, emotion detection, animism[17] and human-machine-relationships. The ROBODADA project consciously takes a "show, don't tell" approach with minimum need of technical background knowledge, to take users on an emotional journey through the topics described. We aim at facilitating easy access for educators to use this tool, e.g. in a workshop setting. These workshops could intend to explore faking one's emotions, causing the machine to take you deadly serious, or narrowing complex feelings down to what the pre-trained model of the algorithm is capable of detecting. On the other hand, we aim at ease of use for professionals like designers or sociologists. The platform provides a relatively readily accessible setup for further exploration, i.e. the robot is reduced to two axes of motion—meaning two servomotors—, which can be shaped and extended in any fashion.

Using the computer mouse to predefine motion paths, the user is put into the position of a puppeteer, performing the robot's movements, which are then mapped to the user's emotions. ROBODADA interprets the user's emotion with face-api.js[18] using a machine learning classifier based on the seven basic emotions by Ekman[19]. The user's non-trivial behavior is classified by a pre-

16 Paul Ekman. (1999). Basic Emotions, Handbook of Cognition and Emotion. 46–60.

17 Marenko, B. (2014). Neo-animism and design: A new paradigm in object theory. Design and Culture, 6(2), 219-241.

18 Mühler, (2019). face-api.js.

19 Ekman, (1999). Basic Emotions.

20 Barrett, et al. (2019). Emotional expressions reconsidered.

trained model and mapped to a discrete state. To emphasize the narrowing of information, we overlay the face of the user in the camera preview with the respective emoticons. We are aware that machine-based emotion detection should be discussed critically [20]. ROBODADA underlines that a machine is not able to detect "real" human emotions. It just arrives at the conclusion that the faces detected translate into numeric values that represent a pre-trained emotional class.

Instead, we consider ROBODADA a playful interaction and research tool that stimulates further discussion and raises the following questions:

- To which level can a machine detect and evaluate our behavior?
- How do we interpret the corresponding body language of a machine?
- How does the machine's output effect our behavior?

Our goal is to offer a tool as simple as possible to explore this problem space—with no coding skills required. The robot module offers endless possibilities to add different analog materials and extensions. ROBODADA also provides multi-user and multi-robot support in a local network for a quick and easy use in workshop formats. Attendees do not need to install any packages or hardware drivers. They just need to open their browser and select their robot.

2.2 How to use?

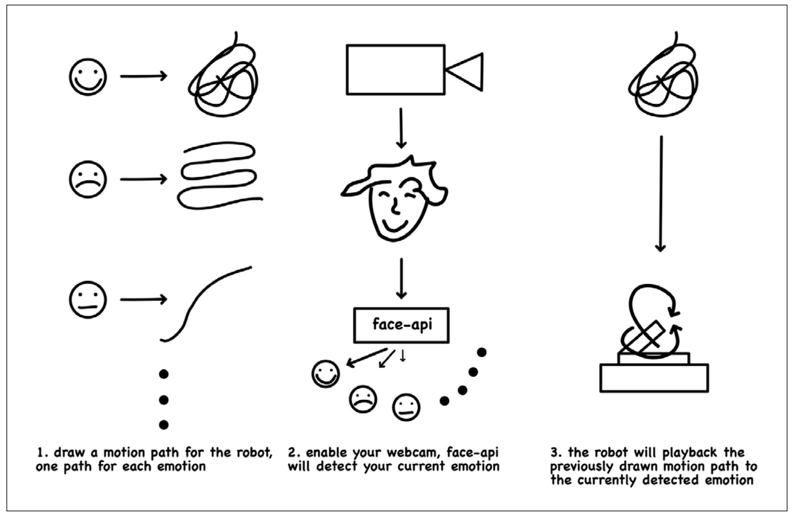

Figure 3: From emotions to movement.

The interaction flow is based on two modes, the "drawing mode" and the "playback mode". While the drawing mode shows seven basic emotions to users, and let them define a motion path for each emotion, the playback mode shows a preview camera feed with an emoticon on top of the detected face, indicating the current emotion. The playback mode then triggers the physical robot's pre-defined motion and lets the robot move.

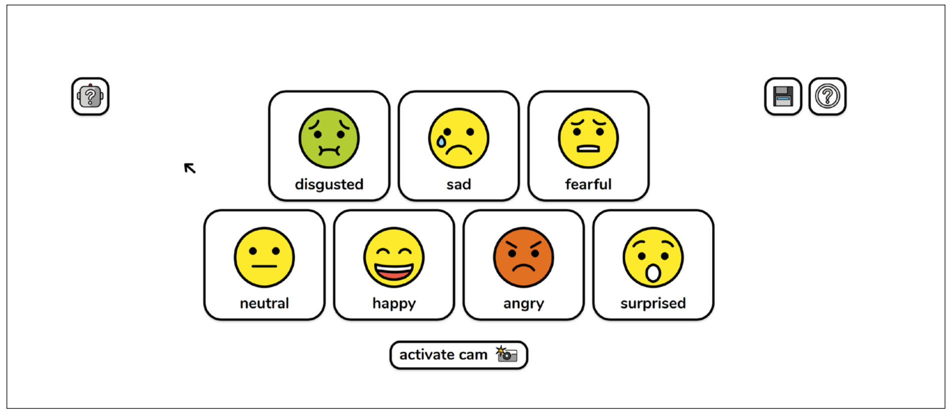

Figure 4: ROBODODA "home screen".

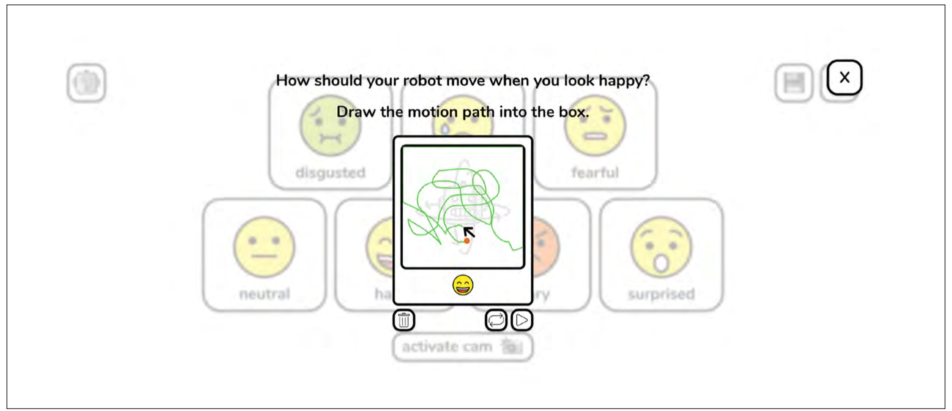

Figure 5: "Drawing mode" while drawing a motion path for "happy".

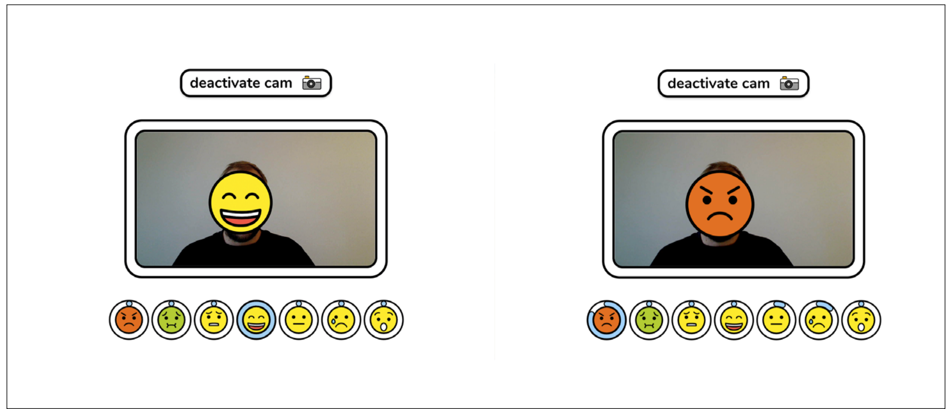

Figure 6: "Playback mode" detecting different emotions.

The robot itself is just a raw pan-and-tilt module in combination with a microcontroller, mounted on top of a wooden box. This setup serves as a starting point. Users should feel free to change this setup according to their needs.

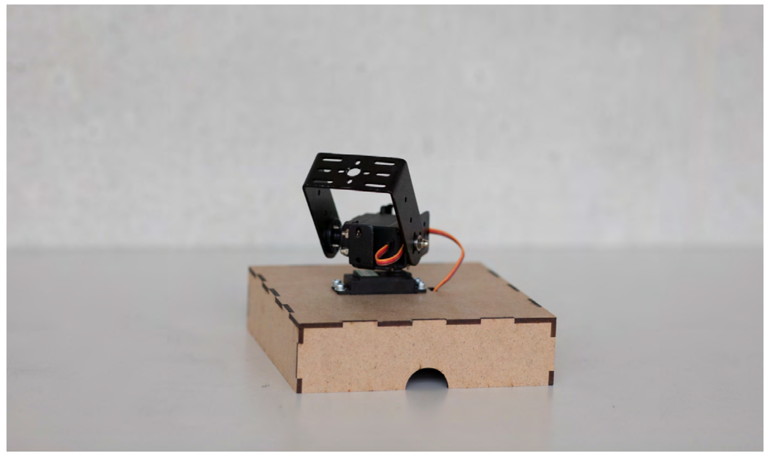

Figure 7: The basic robot platform.

2.3 Technical Details

The server architecture is implemented with Node.js[21], the web interface elements and emojis are based on OpenMoji[22]. For the hardware part, a NodeMCU ESP8266[23] module is used to control the servo motors via open sound control[24] through Wi-Fi. It is only necessary to install the server and configure the NodeMCU modules to run ROBODADA in a local wireless network. The entire interface can be accessed via a browser without any additional software, making this setup ready-to-use in workshop settings, to which people often bring their own devices.

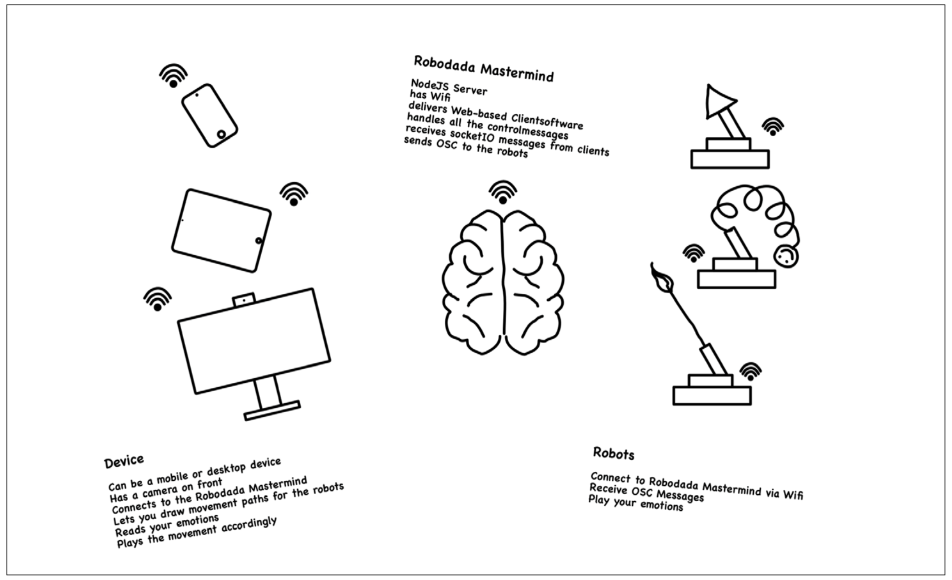

Figure 8: Device communication.

2.4 Build Your Own Robot

Reaching out to designers, sociologists and other low-tech or no-tech disciplines, we would like to give these communities everything that is needed for a playful experience and a practice-based research approach. The robots are fully customizable,

21 Node.js. "A JavaScript runtime built on Chrome's V8 JavaScript engine". (October 27, 2020). https://nodejs.org.

22 Groß, Benedikt. Utz, Daniel et. al. (October 27, 2020). "OpenMoji", https://openmoji.org.

23 NodeMCU. "An open-source firmware and development kit that helps you to prototype your IOT product within a few Lua script lines". (October 27, 2020). http://www.nodemcu.com.

24 OpenSoundControl, "an Enabling Encoding for Media Applications", (October 27, 2020). http://opensoundcontrol.org.

and not necessarily need to be built like the suggested reference design. Either take it apart or build something completely new—the kit allows you to customize it as easy as possible. The idea behind the full customization is a use case in which workshop attendees can design their own robot and explore the body language of the machine playfully. Following a research through design methodology[25], we consider our platform an ideal starting point for a systematic and reproducible exploration rooted in design practice. The robotic objects are not understood as pre-versions for a later implementation but as research artifacts. ROBODADA supports design as a method to produce knowledge for other disciplines and hope to spark transdisciplinary discussions about affective computing, domestic robotics and otherness, with the help of embodied knowledge.

A comprehensive tutorial with all the needed files for hard- and software is available on Github: https://github.com/HybridThingsLab/robodada

3. ROBODADA AT THE DAI CONFERENCE

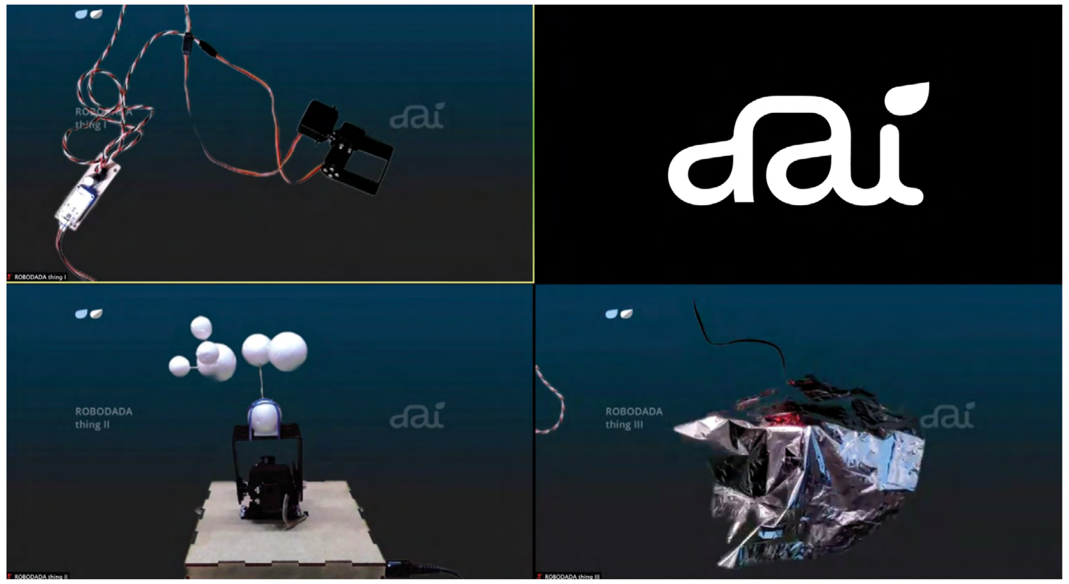

Figure 9: ROBODADA at dai conference.

Due to the COVID-19 pandemic in 2020, the "Designing with Artificial Intelligence (dai)" conference [26] was not held physically, the initial concept of a hands-on workshop with ROBODADA was developed further as a performance during the digital conference.

25 Zimmerman, J., & Forlizzi, J. (2014). Research through design in HCI. In Ways of Knowing in HCI (pp. 167–189). https://doi.org/10.1007/978-1-4939-0378-8_8.

26 Designing with Artificial Intelligence, dai digital. (September 17-19, 2020). https://www.designing-artificial-intelligence.eu.

3.1 Setup Performance

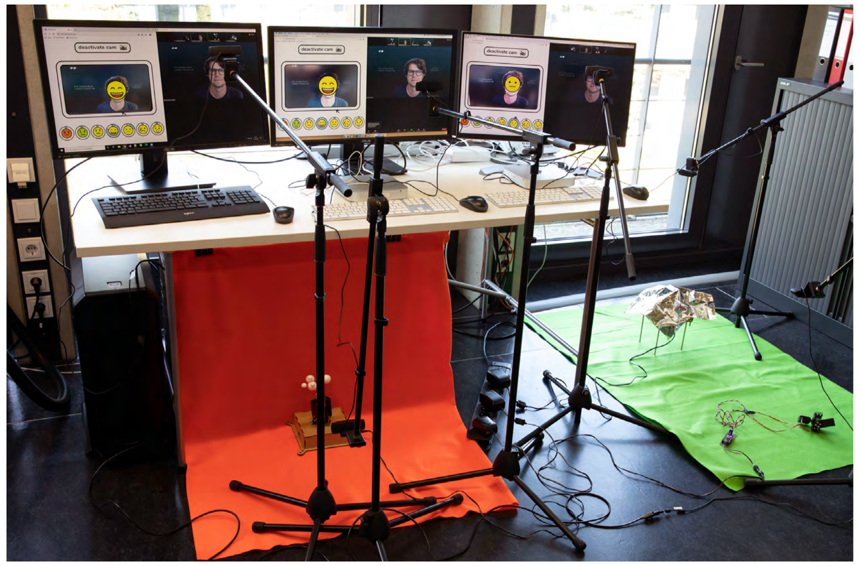

Figure 10: Setup for the dai digital ROBODADA performance.

For the conference, we used the basic setup of ROBODADA and adapted the toolkit to work in the context of a Zoom stream. Three robotic objects named "Thing I," "Thing II," and "Thing III" joined the conference as representatives of a "non-human" species.

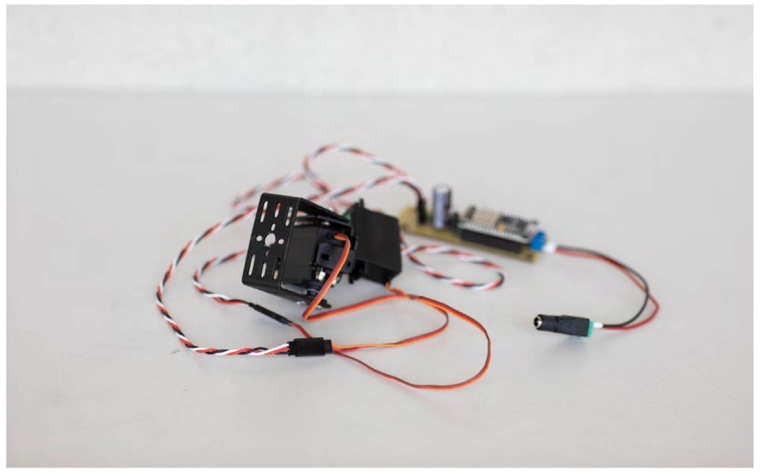

Figure 11: "Thing I".

"Thing I" unveils the raw hardware components of ROBODADA—a microcontroller and two servo motors connected to a pan-and-tilt module. It represents a state of "not finished yet", something still to be shaped and defined.

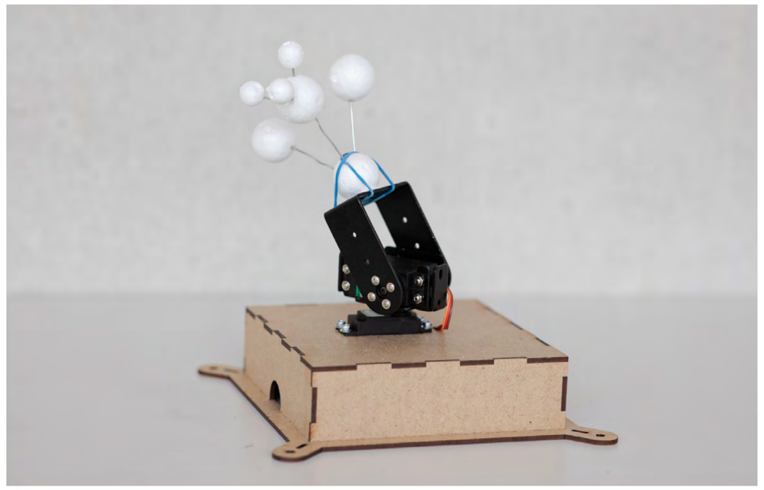

Figure 12: “Thing II”.

“Thing II” represents the DIY approach of the toolkit, because users of the toolkit are free to customize a module for individual needs with analog materials and extensions. Our assumption is that different bodies shape different characters and meanings.

Figure 13: “Thing III”.

“Thing III” hides all the hardware of a module. The robotic structure is covered in a thin metal foil constantly translating the mechanical movement into a fluid and shifting shape.

During the presentations and panel discussions of the conference, the facial expressions of the active speaker were analyzed and assigned to corresponding reactions and movements of the robotic bodies. In order to achieve this, each entity was equipped with two cameras: one camera to analyze the active speaker and one camera to be visible to the audience. Since the conference participants were asked to use virtual backgrounds, and Zoom is optimized for human-to-human communication the robots had to be put in front of monochrome backgrounds to allow chroma keying which enabled the virtual background feature also for robotic participants.

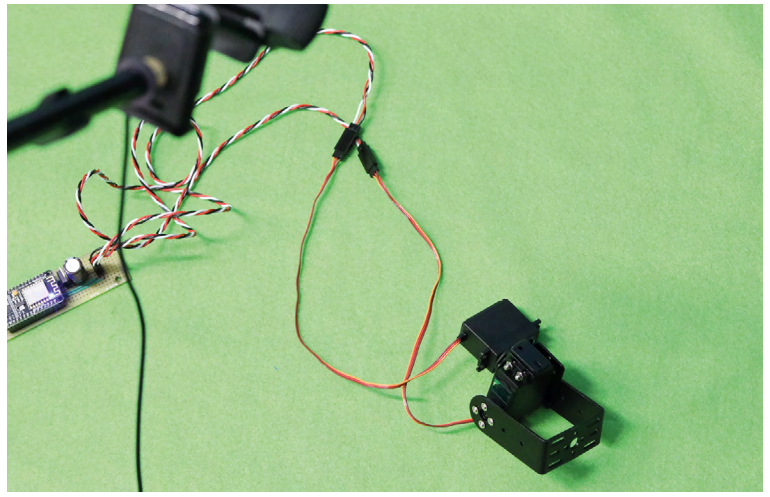

Figure 14: Setup virtual background and chroma keying.

Although the appearance of all robots was very abstract and non-anthropomorphic the autonomous movement created effects of autonomy and animacy. The three things became “others” with which the human participants of the conference had to find a way of dealing.

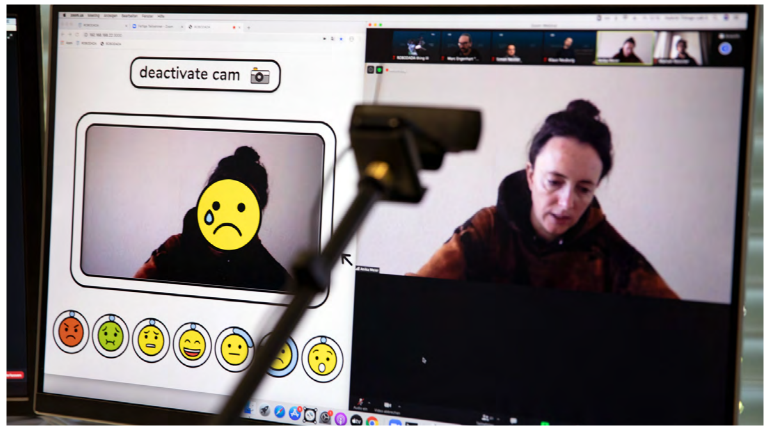

Figure 15: Detection of facial expression.

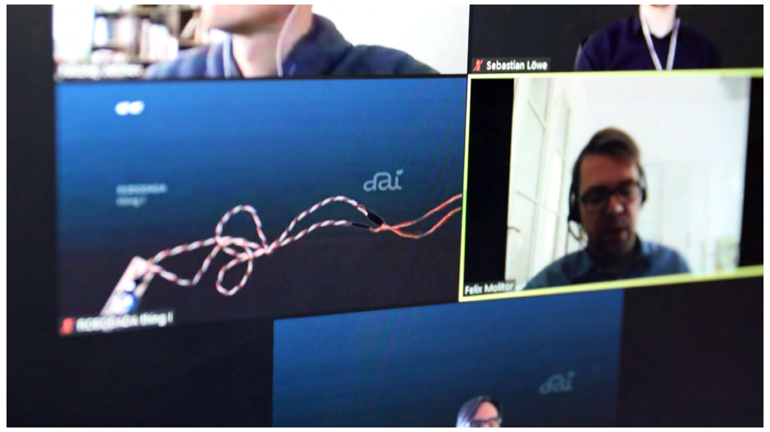

Figure 16: “Thing I” being part of a dai panel discussion.

3.2 Reflection

During the conference participants became quite curious about the robotic objects. But no explanation was offered during the event until the end, when we finally revealed the idea and implementation of ROBODADA. We discovered that even micro movements of the robots were enough to get the attention of human participants. But we assume that the connection of facial expressions to robotic motion was not clear at first. Eventually, the toolkit serves as a kit for hands-on workshops where the robots can be customized and experienced in real life. In virtual formats, we still see a lack for direct physical interaction, nevertheless the performance offered first valuable insights. For example, during one panel, the automated movement of a robot was performed manually again and the context of the current discussion was taken up. In this moment, we experienced a stronger reaction from the other participants, which is due to the fact that the context of a conversation also plays an important role in the interpretation of corresponding body language.

4. DISCUSSION

As the relationship between human and machine changes and algorithms take the next step by imitating intelligence, there is a need to address a broader audience to show and discuss topics like affective computing, emotion detection, animism and human-robot interaction. ROBODADA takes a "show, don't tell" approach with minimum need for software and hardware training, while supporting research through design methods. In general, robotic objects have a lot of potential to make invisible algorithms visible again as they act through mechanical means directly confronting us and creating embodied friction.

While we share the same laws of physics with robots, the perception of this interaction (for example considering robots anthropomorphic or zoomorphic) is not necessarily the same. We suppose that the quality of robotic movement and materiality plays a greater role in human-robot interaction than previously assumed. Design education still lacks experience, knowledge and further approaches and methods to design the otherware that is needed. Exploring alternative modes of interaction, we were able to create and speculate on technical bodies which could soon evolve into social entities of otherness. We are convinced that design—among other disciplines—will play a significant role in shaping these future counterparts.

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