Check for updates

ESSAY

Designing speculative nonhuman-robot scenarios: An artistic approach

[version 1; peer review: 1 approved, 1 approved with reservations]

Ivan Iovine

Electronic Media Arts, University of Art and Design Offenbach am Main, Offenbach am Main, Hesse, 63065, Germany

v1 **First published:** 14 Aug 2024, **4**:182
https://doi.org/10.12688/openreseurope.17441.1
Latest published: 14 Aug 2024, **4**:182
https://doi.org/10.12688/openreseurope.17441.1

Abstract

In the rapidly evolving field of robotics, a new paradigm is emerging that goes beyond anthropocentric design and embraces the innate ingenuity of the natural world. This article seeks to unveil ecocentric and more-than-human approaches, along with innovative materials, in creating nonhuman robotic scenarios within an artistic framework. Building on the foundation laid by anthropomorphic concepts depicted in science fiction, this article seeks to show cutting-edge experiments and material applications that imagine potential more-than-human scenarios in a robotic context. By highlighting examples from robotics, soft robotics, plant neurobiology, and material research, the article aims to propose an alternative concept to anthropomorphism. It endeavors to offer an overview of cutting-edge scientific efforts, experimental designs, and material explorations, all of which converge toward the realisation of robotic scenarios inspired by the animal and natural kingdom.

Plain language summary

A new and innovative approach is taking shape in the world of robotics, moving away from classical human-based approaches and opening up to new forms of interactions that go beyond the usual replication of human motor functions. This new direction explores the concept of robots that are not just based on human forms, but are inspired by the animal and natural worlds, incorporating materials and mechanisms that mimic the efficiency and adaptability observed in various ecosystems, both animal and natural. The goal is to understand and apply the basic principles that make these systems so resilient and versatile. Looking beyond the familiar terrain of science fiction and anthropomorphic robots, researchers and designers are experimenting with advanced materials and exploring new scenarios in which robots could operate in ways observed in nature, inspired by the various forms and functions found in the animal and plant worlds. The results of this research may lead to the development of so-called

Open Peer Review

Approval Status ✓ ?

	1	2
version 1 14 Aug 2024	✓ view	? view

1. **Isabel Neto**, University of Lisbon, Lisbon, Portugal

2. **Noor Stenfert Kroese**, University of Art and Design Linz, Linz, Austria

Any reports and responses or comments on the article can be found at the end of the article.

"soft" robots, or the creation of robots with intelligent and sustainable material forms.

Keywords
robotics, ecocentric robotics, human more-than-human interaction, biomimicry

This article is included in the COST Actions gateway.

This article is included in the Non-machines: Playground of perspectives collection.

This article is included in the Toolkit of Care collection.

Corresponding author: Ivan Iovine (iovine@hfg-offenbach.de)

Author roles: Iovine I: Investigation, Methodology, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: This project has received funding from the European Union's Framework Programme for Research & Innovation as part of the COST Action No CA21102 (COST action, Toolkit of Care).

Copyright: © 2024 Iovine I. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Iovine I. **Designing speculative nonhuman-robot scenarios: An artistic approach [version 1; peer review: 1 approved, 1 approved with reservations]** Open Research Europe 2024, **4**:182 https://doi.org/10.12688/openreseurope.17441.1

First published: 14 Aug 2024, **4**:182 https://doi.org/10.12688/openreseurope.17441.1

Introduction

In the rapidly evolving field of robotics, a novel paradigm is surfacing—one that goes beyond anthropocentric design and embraces the innate ingenuity of the natural world. This article endeavors to unveil ecocentric and more-than-human approaches, along with innovative materialities, in the creation of nonhuman-robot scenarios within an artistic framework. Building upon the foundations set by anthropomorphic concepts depicted in science fiction, this article seeks to showcase cutting-edge experiments and material applications that envision potential more-than-human scenarios in a robotic context. By proposing an alternative concept to anthropomorphism, this article aims to present a summary of scientific efforts, experimental projects, and state-of-the-art material explorations, all converging towards the realization of nonhuman-inspired robotic scenarios.

Sci-fi and the inspiration for human-centered anthropomorphic robotics

The development of human-centered anthropomorphic robotics, a multidisciplinary field merging science, engineering, and psychology, has been consistently influenced by works of science fiction. These works, in turn, have acted as catalysts for the advancement of more sophisticated anthropomorphic robots. The worlds created by science fiction writers have often anticipated and inspired real-world technological advancements, especially when it comes to the concept of humanoid robots. In this chapter, we will explore the significant role science fiction has played in inspiring anthropomorphic robotics and how cinematic works have popularized the notion of human-like robots, sparking fascination and research in this field.

The influence of science fiction. The fascination with the creation of artificial entities in the image and likeness of human beings has always captured the human imagination. This fascination has been amplified by speculative narratives that delve into the moral, psychological and social ramifications of such constructs. Works such as Karel Čapek's "Rossum's Universal Robots" (RuR)[1] and Isaac Asimov's "I, Robot"[2] pioneered the fundamentals of robotics and artificial intelligence, sparking ethical debates and reflections on the implications of human-machine interaction. However, it was the world of cinema that translated these concepts into visually appealing experiences. Works such as "Blade Runner", adapted from Philip K. Dick's novel[3], and Alex Garland's "Ex-Machina"[4], have brought the notion of anthropomorphic robots to the forefront, while also inspiring the world of science and development in the field of robotics. A case in point is the anthropomorphic design of Sophia, currently the most sophisticated android, which bears remarkable similarities to Ava, the android featured in Garland's "Ex-Machina" (Figure 1).

Anthropomorphism and the attempt to integrate robots into the real world. The aim of anthropomorphic robotics is to enhance interactions between humans and robots, particularly within complex human environments such as homes, hospitals, and workplaces. This approach seeks to minimize the gap between human understanding and machine communication, facilitating the adoption of advanced technologies. Beyond physical resemblance, anthropomorphism involves replicating human behaviors, communication patterns, and interactions. Anthropomorphic robots imitate facial expressions, gestures, and even human emotions, creating a familiar and comfortable user experience. This strategy is pivotal in overcoming psychological and cognitive barriers that might otherwise hinder the acceptance of machines in human contexts. However, the dominance of anthropomorphism has, at times, overshadowed potential directions in scientific exploration that could have considered more-than-human intelligences and strategies present in the natural world.

Limits of anthropomorphism

Anthropomorphic robotics, while captivating and promising in its pursuit of creating machines that mimic human attributes, also faces its set of limitations. This chapter explores the boundaries of anthropomorphism and delves into the challenges and missed opportunities that arise from a sole focus on human-like design and functionality.

Complex realism in movement and dexterity. The quest to develop robots with realistic human-like movements and dexterity is a daunting task. While science fiction has often portrayed robots that perfectly emulate human actions, translating such intricate movement into reality is complex and

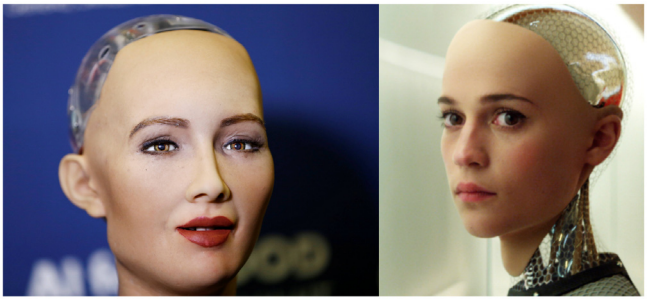

Figure 1. Sophia and Ava. Figure 1 has been reproduced with permission from Reuters/Denis Balibouse and Stephen Cave.[5,6]

[1] Čapek, Karel. (1890–1938). R.U.R. (Rossum's Universal Robots). London ; New York :Penguin Books, 2004.

[2] Asimov, Isaac. (1920–1992). 1950. I, Robot. Garden City, N.Y., Doubleday.

[3] Dick, Philip K. 2007. Blade Runner: (Do Androids Dream of Electric Sheep). New York, Ballantine Books.

[4] Garland, Alex. (2014). Ex Machina. A24.

[5] Zola Ray. "Saudi Robot Sophia Now Wants to Have a Baby." Newsweek, November 28, 2017. https://www.newsweek.com/sophia-saudi-robot-baby-future-family-725254

[6] Cave, Stephen & Dihal, Kanta. (2020). The Whiteness of AI. Philosophy & Technology. 33. 1–19. 10.1007/s13347-020-00415-6. https://www.researchgate.net/publication/343475108_The_Whiteness_of_AI

resource-intensive. Human movement involves an intricate interplay of muscles, tendons and neural coordination. Replicating this complexity in robots requires advanced engineering, sophisticated control algorithms, and a significant investment of time and resources. The pursuit of hyper-realistic motion may divert attention from more efficient alternatives that might be better suited to the robot's intended tasks.

Design limitations and material considerations. The endeavor to design anthropomorphic robots frequently faces constraints that impede efficiency and adaptability. The aspiration to mimic human form may result in designs that are suboptimal for certain tasks. The structural robustness necessary to sustain a humanoid structure might curtail flexibility, speed, or other attributes essential for specialized functions. Furthermore, the materials essential for replicating anthropomorphic characteristics introduce cost and complexity to the construction of the robot. These design and material limitations may inadvertently curtail the robot's potential and its appropriateness for particular applications. Moreover, the materials currently employed in robot design, often produced through digital fabrication technologies reliant on plastics and metals, frequently fall short in terms of sustainability and environmental compatibility.

Beyond human imitation: Overlooking nature's wisdom. Focusing exclusively on imitating human characteristics can lead one to overlook the rich strategies that the natural world offers. Nature has developed an incredible diversity of forms and solutions in the animal and plant kingdoms, each adapted to specific ecological niches and tasks. Emulating these strategies could lead to more efficient and effective robotic designs. An example is the development, in recent years, of bioinspired robotic tools that have drawn inspiration and benefit from animal strategies implemented by octopuses[7] and elephants[8], leading to experimentation and testing of new materialities. It is therefore reasonable to say that sticking strictly to human-like attributes may inadvertently deprive us of the source of bioinspired solutions.

Nonhuman ecocentric robotics

In an era of growing concerns about environmental sustainability, it is proper to think and experiment with new paradigms that can lead to the development of sustainable, robotic artifacts. In this sense, experimentation and research in new disciplines, such as the nonhuman ecocentric robotics. This chapter explores the transformative potential of robot and additive manufacturing technologies that draw inspiration from nonhuman intelligences and embrace sustainable materiality.

Robotics and "Other Intelligences". Advancements in robotics are opening avenues to tap into the intelligence of the natural world. By adopting strategies seen in animals and plants, robots can achieve heightened adaptability across diverse environments and tasks. This mirrors the efficiency and resilience observed in natural organisms. From mastering various movement skills, both on and below ground, to embodying natural abilities like "self-growing", these robots embrace non-anthropocentric approaches to excel at specific tasks. An illustration of scientific progress in this direction is the Plantoid Project, spearheaded by researcher Barbara Mazzolai. The project's aim is to draw insight from the intelligent, efficient strategies employed by plant roots, thereby advancing a novel generation of robots and sensor technologies designed for distributed adaptive intelligence, actuation, and soil exploration and monitoring tasks[9]. The project reached its culmination in the creation of various bioinspired robots, beginning with a plant-like robot named "Plantoid" (Figure 2) and progressing to the development of robotic roots featuring structures akin to natural roots, capable of replicating the self-growing capabilities observed in their natural counterparts. Engineered to penetrate the soil, these robotic roots adeptly adapt to subterranean environments. Powered by an extruder placed on the root tip, they extend their growth by printing Fused Deposition Modeling (FDM) material that elongates the apex, soaking into different soils (Figure 3). FDM is a widely-used technique where thermoplastic material is melted and extruded through a nozzle to create three-dimensional objects[10].

Robotics and ecological design. In the realm of ecological design, 3D printing with natural materials stands out as a



Figure 2. A "Plantoid" developed during the Plantoid project. Figure 2 has been reproduced with permission from Barbara Mazzolai.[11]

[7] Burrows, Leah. 2020. "The Tentacle Bot". https://seas.harvard.edu/news/2020/02/tentacle-bot

[8] Kang, Minchae, Ye-Ji Han, and Min-Woo Han. 2023. "A Shape Memory Alloy-Based Soft Actuator Mimicking an Elephant's Trunk" *Polymers* 15, no. 5: 1126. https://doi.org/10.3390/polym15051126

[9] Sadeghi, Ali, Del Dottore, Emanuela, Mondini, Alession, Mazzolai, Barbara. 2020. "Passive morphological adaptation for obstacle avoidance in a self-growing robot produced by additive manufacturing". Soft robotics 7 (1), 85–94. https://doi.org/10.1089/soro.2019.0025

[10] Antreas, Kantaros, Piromalis, Dimitris. (2021). Employing a Low-Cost Desktop 3D Printer: Challenges, and How to Overcome Them by Tuning Key Process Paramdeters. Int. J. Mech. Appl. 2021, 10, 11–19.

[11] "Plantoid - Bioinspired Soft Robotics - IIT," n.d. https://bsr.iit.it/plantoid



Figure 3. Self-growing robotic roots developed by Sadeghi *et al.* Figure 3 has been reproduced with permission from Barbara Mazzolai.[12 13]

sustainable alternative to conventional manufacturing techniques. This approach minimizes reliance on synthetic and non-renewable resources. A project that is experimenting and researching with materiality and fabrication technologies in this field is Urban Reef. The project's goals include allowing ecological processes to flourish and self-balance. Research focuses on bio-receptive design; biomaterials for urban design and biodiversity; and design for ecological interaction[14]. These investigations have led to the development of additive manufacturing technologies capable of printing with sustainable materials like mycelium (Figure 4). Mycelium, the intricate network of fungal filaments, serves as a fundamental vegetative part of fungi, playing a vital role in growth and nutrition. Thriving within substrates such as soil or decomposed wood, mycelium functions as an absorptive system drawing nutrients from the surroundings. Mycelium can be processed in order to obtain a consistency that can be used to be printed through the aid of additive manufacturing technologies. When 3D printed, this material offers both structural robustness and leverages the natural self-growing process of roots (Figure 5). Mycelium-based 3D printing presents a biodegradable solution that not only reduces plastic waste during prototyping but also in the production of final artifacts. This sustainable characteristic contributes to the development of more adaptable and eco-friendly robots that have a minimal impact on the environment.

More-than-human strategies and sustainable materiality: Connecting the dots. The fusion of nonhuman strategies and sustainable materiality opens the door to a new era of robotics

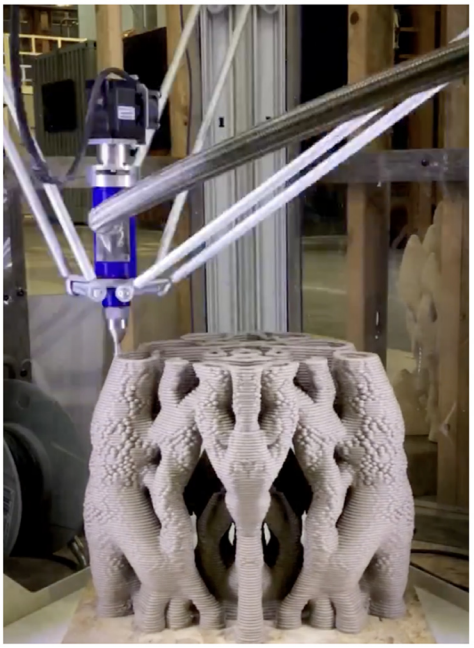

Figure 4. Additive manufacturing techniques using mycelium for 3D printing. Figure 4 has been reproduced with permission from Urban Reef 2023.[15]

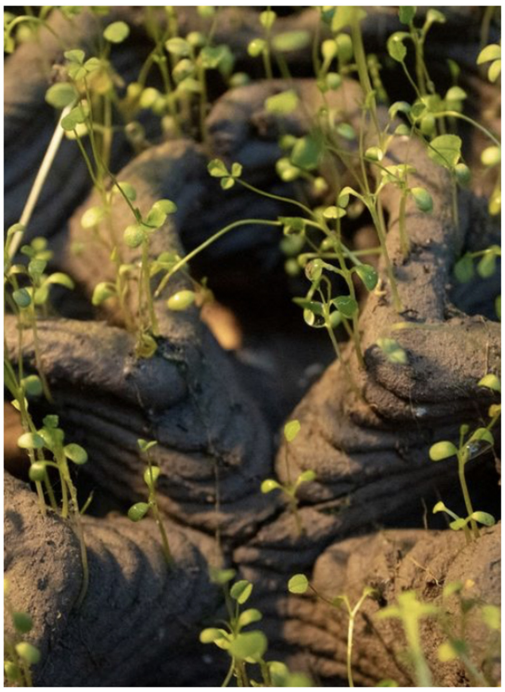

Figure 5. A 3D printed germinating mycelium structure. Figure 5 has been reproduced with permission from Urban Reef 2023.[16]

[12] Ibid.

[13] Sadeghi, Ali, Del Dottore, Emanuela, Mondini, Alessio, Mazzolai, Barbara. 2020. "Passive morphological adaptation for obstacle avoidance in a self-growing robot produced by additive manufacturing". Soft robotics 7 (1), 85–94. https://doi.org/10.1089/soro.2019.0025

[14] Oskam, Pierre. 2022. "Urban Reef: Design for Bio-inclusive Cities". Conference Ecosummit 2022. DOI: 10.13140/RG.2.2.23831.85925

[15] Urban Reef," n.d. https://www.urbanreef.nl/.

[16] Ibid.

in harmony with the environment. By embracing these two aspects, robotics can bridge the gap between artificial and natural systems, paving the way for technologies that are not only functional but also ecological and adaptive. A project that intersects these two domains is one pursued by Valentin *et al.* from Brown University. The endeavor revolves around harnessing the natural polymer, called hydrogel, and its potential in 3D printing for crafting self-responsive and self-adhesive soft robotic entities[17]. Valentin *et al.* engineered a hydrogel-based fabrication capable of enacting survival strategies observed in salamanders in the natural world. The outcome was a creation resembling a salamander, endowed with the ability to shed and reattach its tail, employing the stimuli-responsive and self-adhesive attributes of the hydrogel (Figure 6).

This marks a significant shift from human-centered design principles to an approach that encompasses the broader ecosystem. Natural materials, ranging from robust mycelium-based structures to soft hydrogels derived from natural polymers, offer a spectrum of attributes that suit various robotic applications. This versatility ensures that robots can excel in a range of functions while adhering to the principles of sustainability and ecological sensitivity.

Artistic approach in creating novel nonhuman scenarios

In the realm of robotics and additive manufacturing, a distinct artistic approach is emerging that embraces non-human perspectives and seeks to create novel scenarios inspired by the wisdom of nature. This chapter explores how the fusion of artistic creativity and technological innovation can lead to the development of robots that transcend human-centric design, drawing on more-than-human strategies and sustainable materials.



Figure 6. 3D printed hydrogel salamander with self-adherent behavior. Figure 6 has been reproduced with permission from Wong Lab at Brown University.[18]

Bridging the gap between technical state of the art and creative robotic. The convergence of artistic expression and robotics offers a unique avenue for imagining non-anthropocentric robotic artifacts. Inspired by the remarkable strategies found in nature, these creations go beyond imitation of human form and function. By drawing on more than human strategies, artists and engineers can come together to create entirely new scenarios. The use of natural and biodegradable materials presented earlier, such as mycelium and hydrogels, allows non-human strategies to be seamlessly integrated into robotics. These materials can not only be used in conjunction with more-than-human strategies that can be reproduced in a robotic context, but also contribute from a sustainability point of view. This harmonious amalgamation aligns with ecological design principles and paves the way for a symbiotic relationship between technology and the environment.

Artistic creation and technical advancement. Artistic creation plays a central role in the genesis of nonhuman speculative scenarios. By imagining robotic forms and functionalities that transcend human limits, artists provide a platform to stimulate innovation and discussions in both artistic and technical fields. These speculative scenarios that aim to challenge conventional assumptions could be the driving force in exploring new possibilities in robotics. The interplay between artistic imagination and technical research is a two-way street. As artists engage in the creation of nonhuman narratives, the demand and need for using sustainable and biodegradable materials increases. This demand, in turn, stimulates technical research into sustainable materiality, thereby contributing to the development of greener robotic technologies. In this sense, a symbiotic relationship would be created between the artistic and technical communities that would lead to encouraging the exploration of more-than-human strategies in robotics.

The confluence of art and technology. Artistic creativity in the realm of robotics transcends aesthetics and delves into the heart of innovation. Drawing on the wisdom of nature and exploring nonhuman speculative scenarios, artists and engineers are collectively pioneering an era of robotics that embraces sustainability, adaptability, and creativity. The artistic approach in creating new nonhuman scenarios in robotics could be a catalyst for change, igniting innovation and promoting research on sustainable materials and more-than-human strategies.

Conclusion

This essay took an interdisciplinary path, merging the frontiers of art, robotics, and ecological design to imagine a new paradigm of robotics that goes beyond traditional anthropomorphic designs. We demonstrated innovative approaches that draw on

[17] Valentin, Thomas M., DuBois, Eric M., Machnicki, Catherine E., Bhaskar, Dhananjay, Cui, Francis R., Wong, Ian Y. (2019). "3D printed self-adhesive PEGDA–PAA hydrogels as modular components for soft actuators and microfluidics". Polym. Chem., 2019,10, 2015–2028. DOI: https://doi.org/10.1039/C9PY00211A

[18] Brown University. "Dynamic Hydrogel Used to Make 'Soft Robot' Components and LEGO-like Building Blocks," March 21, 2019. https://www.brown.edu/news/2019-03-21/hydrogel.

the resilience and adaptability of natural and more-than-human strategies, leveraging advances in materials science to propose alternative and sustainable solutions in the creation of robotic artifacts. The discussion highlighted the significant influence of science fiction in inspiring human-centered robotics and the transformative potential of nonhuman ecocentric robotics that borrows ingenuity from the natural world. Through cutting edge artistic-scientific projects, we explored how robots can emulate the efficient strategies of plant roots or use biodegradable materials such as mycelium for ecological applications. We have seen how artistic endeavors can push the boundaries of conventional robotics, opening new avenues for non-anthropocentric robotic projects in harmony with the environment. Looking to the challenges of the future, the interaction of art and technology, supported by a commitment to sustainability, will be key to creating robotic systems that are not only functional but also ecological and adaptive.

Ethics and consent

Ethical approval and consent were not required.

Data availability

No data are associated with this article.

Bio

Ivan Iovine is an interaction designer, researcher and artist based in Frankfurt am Main. His artistic and media practices range from digital art to robotics and machine learning. Iovine uses emerging technologies to blend virtual and physical worlds, creating speculative scenarios that highlight challenges and issues in the use (or disuse) of these innovations and how these affect social contexts and paradigms.

He has exhibited his work in various international festivals and museums such as Lab30 (Augsburg - 2019), Piksel Festival (Bergen - 2020–2022), Die Digitale (Düsseldorf - 2021), Dortmunder U (Dortmund - 2020), Run Run Shaw Creative Media Centre (Hong Kong - 2021) and CENART (Mexico City - 2023). In 2016 he was invited by Arduino to attend the "Casa Jasmina" residency coordinated by writers and futurists Sterling and Tesanovic. He has written artistic and scientific publications for conferences like "Art Machines 2: International Symposium on Machine Learning and Art" (CityU Hong Kong - 2021) and "State of Interim" (HFBK Hamburg - 2022). In addition to his artistic activities, he is leading the robotics lab at HfG Offenbach since May 2022, lecturing on robotics, machine learning and computer vision. In the context of the KITeGG research project he published the scientific paper "Integrating Artificial Intelligence and Robotics into Art Curriculum" presented at INFORMATIK2023.

Open Peer Review

Current Peer Review Status: ✔ ?

Version 1

Reviewer Report 17 October 2024

https://doi.org/10.21956/openreseurope.18848.r43513

© **2024 Stenfert Kroese N.** This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

?

Noor Stenfert Kroese
Creative Robotics, University of Art and Design Linz, Linz, Upper Austria, Austria

The article “Speculative Nonhuman-Robot Scenarios: An Artistic Approach” by Ivan Iovine is a well-written and accessible piece that highlights an important shift in robotics—away from anthropocentric, humanoid designs and toward an exploration of nonhuman approaches. This interdisciplinary perspective fostered through an exchange between science, art, and design, is refreshing and necessary in a field often dominated by technical and industrial narratives.

The article succeeds in introducing humanoid robotics, addressing its presence in both science fiction and real-world applications while gradually leading the reader to broader possibilities for robot design inspired by nature. This shift—exploring how robots can be conceptualized and designed not only to mimic humans but also to take inspiration from the animal and plant kingdoms—represents an engaging contribution.
One major limitation, however, is the article's narrow scope of references. For an article that claims to offer an overview of cutting-edge scientific efforts, experimental designs, and material explorations, this limited pool of references does not provide the depth necessary to fully represent the state of the field. The examples mentioned, such as the work of Barbara Mazzolai and the Urban Reef project, are relevant and compelling, but they do not provide a complete picture. The article would benefit from including more examples from both the scientific and artistic fields, especially in distinguishing between applied (speculative) design approaches with robotics, often seen in architecture and material research, and more (speculative) artistic explorations.

The speculative aspect of the article also remains somewhat unclear. Although the title suggests a focus on “speculative robotics,” the concept is not adequately explained or fully explored. Speculative robotics, as implied, should involve the creation of future scenarios that challenge current paradigms. However, the article does not clarify what this speculation entails or how it differs from, for example, experimental robotics. A clearer definition of what is meant by “speculative” in this context would strengthen the article’s argument.

The notion of "nonhuman" or "more-than-human" in relation to robotics is intriguing, but similarly

underdeveloped. A more critical and nuanced explanation of how these concepts apply within the context of the examples provided would enhance the reader's understanding. For instance, it remains unclear how projects like Urban Reef integrate mycelium directly into their robotic processes—whether it is extruded during the printing process or added afterward. This distinction is essential for understanding the role of living organisms in robotic interactions and material exploration.
In conclusion, Iovine's article offers a valuable perspective on non-anthropocentric robotic design, highlighting the potential of artistic approaches in expanding the horizons of robotics. However, to fully achieve its stated goals, the article would benefit from a deeper engagement with the concepts of nonhuman perspectives, as well as a more comprehensive selection of examples and references from the scientific, artistic and design field.

References recommended:
Alima N, 2023 (Ref 1)
Darling, K. (2021) (Ref 2) on our evolving history with animals and robots, would significantly enrich the discussion,
Eichinger, M, et al., 2022 (Ref 3)
Elsacker, E, et al., 2022 (Ref 4) on large-scale robotic extrusion with living mycelium materials,
Elhadad A, et al., 2024 (Ref 5)
https://kons-platforma.org/en/projekti/stellaverde/
Justus K, et al., 2019 (Ref 6)
Reynolds-Cuéllar, P, et al., 2023 (Ref 7)

References

1. Alima N: InterspeciesForms the hybridization of architectural, biological and robotic agencies. *Architectural Intelligence*. 2023; **2** (1). Publisher Full Text
2. K, Darling: The New Breed How to Think About Robots. *https://cdn.penguin.co.uk/dam-assets/books/9780141988641/9780141988641-sample.pdf*. 2021.
3. M, Eichinger E, Gollob JA, Escudero V, et al.: Growing Whole Bacterial Cellulose Garments with Membranes and Industrial Robotics.
https://www.researchgate.net/publication/370638149_Growing_Whole_Bacterial_Cellulose_Garments_with_Membranes_a
2022. Publisher Full Text
4. Elsacker E, Peeters E, De Laet L: Large-scale robotic extrusion-based additive manufacturing with living mycelium materials. *Sustainable Futures*. 2022; **4**. Publisher Full Text
5. Elhadad A, Gao Y, Choi S: Revolutionizing Aquatic Robotics: Advanced Biomimetic Strategies for Self-Powered Mobility Across Water Surfaces. *Advanced Materials Technologies*. 2024. Publisher Full Text
6. Justus K, Hellebrekers T, Lewis D, Wood A, et al.: A biosensing soft robot: Autonomous parsing of chemical signals through integrated organic and inorganic interfaces. *Science Robotics*. 2019; **4** (31). Publisher Full Text
7. PR, Cuéllar AF, Salaza-Gomez: Nature-Robot Interaction.
https://dl.acm.org/doi/10.1145/3568294.3580034. 2023.

Is the topic of the essay discussed accurately in the context of the current literature?
Partly

Is the work clearly and cogently presented?

Partly

Is the argument persuasive and supported by appropriate evidence?
Partly

Does the essay contribute to the cultural, historical, social understanding of the field?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Creative robotics, Non-human interaction with robotics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 14 September 2024

https://doi.org/10.21956/openreseurope.18848.r43517

© 2024 Neto I. This is an open access peer review report distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Isabel Neto
Instituto Superior Técnico, INESC-ID, University of Lisbon, Lisbon, Portugal

Overall, this paper focuses on the potential of looking into robots from a non-anthropomorphic point of view. It is a very engaging and well-written paper with examples of robots from sci-fi, industry, and nature. Additionally, it starts reflecting on the impact and limitations of the traditional anthropomorphic view of robots and the benefits and applications of expanding this view.
Significant contributions are the reflections on the limitations of using an anthropomorphic approach to robots, highlighting the complexity of human interactions that lead to complex, overly expensive robots focused on proving an "almost" human-like interaction and defocusing on the applications for which they are needed.
An important contribution from this paper is the reflection on "*Beyond human imitation: Overlooking nature's wisdom*." Looking into other perspectives and exploring the benefits of using more-than-human perspectives on robots as inspirations for new solutions. Moreover, it was interesting to see seminal work made on the topic by Barbara Mazzoli's and Urban Reef's work.
However, I still find the discussion on a more-than-human perspective in the framework of an art short. Moreover, the more-than-human perspective in robotics is starting to have broader work than just Barbara Mazzoli's and Urban Reef's work).
Therefore, my major concerns and suggested improvements before acceptance are:

- Can you give more diverse examples of more-than-human perspectives?
    1. I recommend and overview of recent work on different materials and concepts on the topic, for example [ref 1], [ref 2], [ref 3]

2. There are already some explorations on non-anthropomorphic concepts in HRI. That lead to the idea of robomorphism and more-than-human perspectives. That could enrich the argument of the paper, for example [ref 4], [ref 5]
3. Add other works from robotics and their different applications outside human-like interaction. for example
    1. Bio robotics, which can add a Human medicine focus on this concept of more-than-humans robots, they are intended for medicine, not for human interaction.
    2. The same applies to industrial robotics, agriculture, cars, etc...
4. Moreover, I think there are too many details on the assembly process of Barbara's Mazzoli work, that is not critical for the paper

- One of the contributions claimed by the paper is that an art perspective can enrich the reflection of robot design. I found it challenging to support that claim contribution from reading the three final sections of the paper. I agree with the authors about the potential of arts and speculative design for robot design and as a driver for innovation (such as science fiction). Yet, I needed help to see enough information to claim this from an arts framework perspective in the paper. Can the authors elaborate on that, enriching the contributions of this arts-technology approach? Can you give more art-related examples of robots and explore the potential of design and speculative methods to innovate in this field?

Looking forward to see the next version of the paper.

References

1. Hu Y, Lu J, Scinto-Madonich N, Pineros M, et al.: Designing Plant-Driven Actuators for Robots to Grow, Age, and Decay. *Association for Computing Machinery*. 2024. Reference Source
2. Lu J, Lopes P: Integrating Living Organisms in Devices to Implement Care-based Interactions. *Association for Computing Machinery*. 2022. Reference Source
3. Mishra AK, Kim J, Baghdadi H, Johnson BR, et al.: Sensorimotor control of robots mediated by electrophysiological measurements of fungal mycelia.*Sci Robot*. 2024; **9** (93): eadk8019 PubMed Abstract | Publisher Full Text
4. Reference Source
5. Schouten A, Portegies T, Withuis I, Willemsen L, et al.: Robomorphism: Examining the effects of telepresence robots on between-student cooperation. *Computers in Human Behavior*. 2022; **126**. Publisher Full Text

Is the topic of the essay discussed accurately in the context of the current literature?

Yes

Is the work clearly and cogently presented?

Yes

Is the argument persuasive and supported by appropriate evidence?

Yes

Does the essay contribute to the cultural, historical, social understanding of the field?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Social robotics and soft robotics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.