

Designing Trustworthy Robot Swarms for Real-World Applications

Sabine Hauert
University of Bristol
Bristol, United Kingdom
sabine.hauert@bristol.ac.uk

ABSTRACT

Building on two decades of progress, swarm robotics is approaching the point where it can deliver out-of-the-box solutions for real-world environments that are adaptive, scalable, and robust.

Realising this potential requires moving beyond the traditional view of swarms as large collectives of simple, autonomous, and homogeneous agents that rely solely on local sensing and interactions. Instead, we argue for a new paradigm in which swarms leverage advances in AI [4], integrate richer local perception, and exchange information not only locally but also through global or quasi-global communication [2].

In this vision [1], swarms of specialised robots operate with shared situational awareness [5], enabling them to coexist and coordinate seamlessly across a wide range of applications, including medicine, construction, agriculture, logistics, and environmental protection.

Underpinning this vision is the need to co-design swarm systems with communities and stakeholders, ensuring they are ethical [7], trustworthy [6], and safe [3]. This includes developing systematic approaches to engineer emergent behaviours that are transparent and amenable to human design, monitoring, control, and validation.

The long-term goal is to foster an ecosystem in which next-generation robots collaborate with one another - and with humans - at scale.

KEYWORDS

Swarm Robotics, Swarm Engineering, Multi-agent Systems, Machine-Learning, Evolutionary Computation

ACM Reference Format:

Sabine Hauert. 2026. Designing Trustworthy Robot Swarms for Real-World Applications. In *Proc. of the 25th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2026)*, Paphos, Cyprus, May 25 – 29, 2026, IFAAMAS, 1 page. <https://doi.org/10.65109/http://doi.org/10.65109/FYJB3472>

BIOGRAPHY

Sabine Hauert is Professor of Swarm Engineering at University of Bristol. She leads a team of 20 researchers working on making swarms for people, and across scales, from nanorobots for cancer

treatment, to larger robots for environmental monitoring, or logistics (<https://hauertlab.com/>). Before joining the University of Bristol, Sabine engineered swarms of nanoparticles for cancer treatment at MIT, and deployed swarms of flying robots at EPFL. She's PI or Co-I on more than 40M GBP in grant funding and has served on national and international committees, including the UK Robotics Growth Partnership, the Royal Society Working Group on Machine Learning, and several IEEE RAS boards. She is on the board of directors of the Open Source Robotics Foundation and is Executive Trustee of non-profits robohub.org and aihub.org, which connect the robotics and AI communities to the public. In 2026, she was awarded an Honorary OBE for services to robotics.



ACKNOWLEDGMENTS

SH is funded by EPSRC grants UKRI2030 and UKRI1890, ESRC grant ES/W002639/1, and Horizon Europe Project 101070918 supported by UKRI grant number 10038942.

REFERENCES

- [1] Ophelia Deroy, Davide Bacciu, Bahador Bahrami, Cosimo Della Santina, and Sabine Hauert. 2024. Shared Awareness Across Domain-Specific Artificial Intelligence: An Alternative to Domain-General Intelligence and Artificial Consciousness. *Advanced Intelligent Systems* 6, 10 (2024), 2300740.
- [2] Henry Hickson, Sabine Hauert, and Alex Mavromatis. 2025. Back to Bee-sics: Learning Information Sharing Strategies for Robot Swarms Through the Hive. In *Artificial Life Conference Proceedings* 37. MIT Press, 78.
- [3] Edmund R Hunt and Sabine Hauert. 2020. A checklist for safe robot swarms. *Nature Machine Intelligence* 2, 8 (2020), 420–422.
- [4] Jess Jones, Sabine Hauert, and Raul Santos-Rodriguez. 2026. Assessing VLM-Driven Semantic-Affordance Inference for Non-Humanoid Robot Morphologies. In *Proceedings of the 25th International Conference on Autonomous Agents and Multiagent Systems*.
- [5] Simon Jones and Sabine Hauert. 2025. Distributed spatial awareness for robot swarms. *Autonomous Robots* 49, 4 (2025), 41.
- [6] James Wilson, Greg Chance, Peter Winter, Suet Lee, Emma Milner, Dharminda Abeywickrama, Shane Windsor, John Downer, Kerstin Eder, Jonathan Ives, et al. 2023. Trustworthy swarms. In *Proceedings of the First International Symposium on Trustworthy Autonomous Systems*. 1–11.
- [7] Alan FT Winfield, Matimba Swana, Jonathan Ives, and Sabine Hauert. 2025. On the ethical governance of swarm robotic systems in the real world. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 383, 2289 (2025).



This work is licensed under a Creative Commons Attribution International 4.0 License.

Proc. of the 25th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2026), C. Amato, L. Dennis, V. Mascardi, J. Thangarajah (eds.), May 25 – 29, 2026, Paphos, Cyprus. © 2026 International Foundation for Autonomous Agents and Multiagent Systems (www.ifaamas.org). <https://doi.org/10.65109/http://doi.org/10.65109/FYJB3472>