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How to Level Up Soft Robotics

The field of soft robotics has exploded in the past decade, as ever more researchers seek to make real the potential of these pliant, flexible automata in a variety of realms, including search and rescue, exploration and medicine.

For all the excitement surrounding these new machines, however, UC Santa Barbara mechanical engineering professor Elliot Hawkes wants to ensure that soft robotics research is more than just a flash in the pan. “Some new, rapidly growing fields never take root, while others become thriving disciplines,” Hawkes said.

To help guarantee the longevity of soft robotics research, Hawkes, whose own robots have garnered interest for their bioinspired and novel locomotion and for the new possibilities they present, offers an approach that moves the field forward. His viewpoint, written with colleagues Carmel Majidi from Carnegie Mellon University and Michael T. Tolley of UC San Diego, is published in the journal Science Robotics.

“We were looking at publication data for soft robotics and noticed a phase of explosive growth over the last decade,” Hawkes said. “We became curious about trends like this in new fields, and how new fields take root.”

The first decade of widespread soft robotics research, according to the group, “was characterized by defining, inspiring and exploring,” as roboticists took to heart what it meant to create a soft robot, from materials systems to novel ways of navigating through and interacting with the environment.

However, the researchers argue, “for soft robotics to become a thriving, impactful field in the next decade, every study must make a meaningful contribution.” According to Hawkes, the long-term duration of a rapidly growing field is often a matter of whether the initial exploratory research matures.

With that in mind, the group presents a three-tiered categorization system to apply to future soft robotics work.

“The three-tier system categorizes studies within the field, not the field as a whole,” Hawkes explained. “For example, there will be articles coming out this year that will be Level 0, Level 1 and Level 2. The goal is to push as many Level 0 studies toward Level 1 and Level 2.”

From Baseline to Broad Contribution

“Soft for soft’s sake” could be used to characterize Level 0 in the categorization system, as researchers have, for the past decade, rapidly and broadly explored new materials and mechanisms that could fall under the notion of “soft robot.” While these studies were necessary to define the field, according to the authors, maintaining research at this level puts soft robotics at the risk of stagnation.

With the benefits of a solid foundation, present and future roboticists are now encouraged to identify areas for performance improvement and solutions to gaps in the knowledge of soft robotics — the hallmark of Level 1. These studies will push the field forward, the researchers said, as novel results could elevate technological performance of soft systems.

However, they say, “whenever possible, we should strive to push beyond work that only contributes to our field.” Studies in the Level 2 category go beyond soft robotics to become applications in the broader field of engineering. Here, softness is more than an artificial constraint, according to the paper; rather, it “advances state-of-the art technology and understanding across disciplines” and may even displace long-used conventional technologies.

One way to move beyond Level 0 lies in the training of the next generation of roboticists, the researchers said. Consolidating the best available knowledge contributed by previous work will prime those just entering the field to “ask the right questions” as they pursue their research.

“We hope that the categorization we offer will serve the field as a tool to help improve contribution, ideally increasing the impact of soft robotics in the coming decade,” Hawkes said.

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