ROBOTICS

Science for robotics and robotics for science


From molecular machines to large-scale systems, from outer space to deep-sea exploration, robots have become ubiquitous, and their impact on our lives and society is growing at an accelerating pace. Science Robotics has been launched to cover the most important advances in robot design, theory, and applications. Science Robotics promotes the communication of new ideas, general principles, and original developments. Its content will reflect broad and important new applications of robots (e.g., medical, industrial, land, sea, air, space, and service) across all scales (nano to macro), including the underlying principles of robotic systems covering actuation, sensor, learning, control, and navigation. In addition to original research articles, the journal also publishes invited reviews. There are also plans to cover opinions and comments on current policy, ethical, and social issues that affect the robotics community, as well as to engage with robotics educational programs by using Science Robotics content. The goal of Science Robotics is to move the field forward and cross-fertilize different research applications and domains.

With this inaugural issue of Science Robotics, we are delighted to bring you a set of papers covering several key aspects of robotics. The Review by Laschi et al. (1) explores the evolution of soft robotics. Soft materials and fabrication techniques have led to deformable structures that give robots the ability to stretch, squash, climb, and morph, with the potential for biodegradability and self-healing. Although a relatively new topic in robotics, soft robotics is changing how actuation, control, and dynamic adaptation are achieved by leveraging parallel advances in material science, chemistry, engineering, biology, and many other disciplines. An example embodiment of soft robotics is a prosthetic hand with stretchable optical waveguides, presented by Zhao et al. (2) in this issue. They used photonic strain sensors to allow for the capture of curvature, elongation, and force, thus permitting active sensation of the proposed optoelectronically innervated prosthetic hand.

One of the ambitions of Science Robotics is to root robotics research deeply into basic science. Biorobotics represents such an ambition: It keeps the living world (and thus life sciences) at its core, investigates different applications of biospired machines and robots, and validates scientific hypotheses. Our attempts to mimic animal motion have already devised many technological advances that have revolutionized how man-made machines move through air, in water, and on land. Despite numerous achievements, engineers and scientists have yet to closely replicate the grace and fluidity of animal movement. This suggests that the biological world still has much to teach, in terms of design inspiration and programming robotic systems with abilities that will far exceed current capabilities.

An example of this innovative thinking can be found in the work of Haldane et al. (3), who devised a metric to quantify vertical jumping agility for both animals and robots. The extracted principles led to a new approach to power modulation, allowing the creation of a much more agile robot that achieves 78% of the vertical jumping agility of a galago.

Advances in robotics have also extended human sensory experience, cognition, and physical abilities. Direct brain control has offered disabled individuals a possibility to restore basic motor function. Soekadar et al. (4) give an example on how a noninvasive, hybrid electroencephalography and electrooculography-based brain and neural hand exoskeleton can restore intuitive control of grasping motions for quadriplegias, allowing them to perform basic daily living activities. As noted by H. Herr, an advisory board member of Science Robotics, “Future technologies will not only compensate for human disability but will drive human capabilities beyond innate physiological levels, enabling humans to perform a diverse set of tasks with both anthropomorphic and nonanthropomorphic extended bodies.” Such augmentative technologies “will have a transformative influence on broad social, political, and economic spheres, affecting the future of sport, labor productivity, human longevity, and disability.”

For roboticists and the general public, the debate over autonomous driving concerns both the technical challenges and, perhaps more importantly, the potential social, ethical, safety, and legal considerations that must be addressed for widespread adoption to occur. Perhaps less explored is the situation where there is a transition between autonomous driving and full human control. Russell et al. (5), in studying motor learning effects during car-to-driver handover in automated vehicles, found that when a human driver retakes control, an extensive period of motor adaptation may be required to resume normal steering behavior. Designers of automated vehicles may thus need to carefully consider this period of compromised steering behavior when developing methods for control handover.

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It is our intention that *Science Robotics* will bear the quality hallmark of the *Science* family of journals and cover both the traditional disciplines of robotics and emerging trends, such as advanced materials and bioinspired designs. It will also cover all scales, from very large systems to micro- and nanorobots. The 2016 Nobel Prize in Chemistry honors three pioneers in this field who designed and built some of the first molecular machines. Despite the progress in crafting structures of increasing complexity at such a small scale, truly functional dynamic nanorobots that are autonomous and that can undertake useful tasks are still in their infancy. This is in contrast to any living organism, where dynamic biological nanomachines are ubiquitous and where they accomplish functions that are readily observed at the macroscopic scale. The challenges faced in realizing synthetic autonomous nanorobots that can rival their biological counterparts, and that perhaps ultimately lead to medically useful applications, are manifold. We hope to see many original papers on nanorobots submitted to *Science Robotics* in the future because they truly require the combination of basic science and robotics to develop suitable fabrication and assembly strategies, to address questions of control and communication, and to solve the difficulty of power transfer to small scales.

We hope that you enjoy the first issue of *Science Robotics* and join us in this exciting robotics venture as we strive to transform the future of robotics for the benefit of all.

**REFERENCES**


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