

Plant-like soft robots growing by additive manufacturing

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A rich literature exists in bioinspired robotics and recently the use of soft materials and variable stiffness technologies represents an emerging way to build new classes of robotic systems that are expected to interact more safely with natural unstructured environments and with humans, and that better deal with un-certain and dynamic tasks. Despite the big achievements in this field, robotic technologies are still insufficient to mimic the biological system capabilities in changing their morphology and adapting their body and functionality during their lifetime. In this perspective, we are considering plants as an interesting model of movement in robotics, as well as distributed perception and control, self-growing and adaptable features.

Plants are still a quite unexplored model in robotics and ICT technologies, as their sessile nature leads to think that they do not move. Instead, they move greatly, on a different time scale, purposively, effectively and efficiently. To move from one point to another, plants must grow and continuously adapt their body to the external environmental conditions. By imitating them, our goal is to develop low-mass and low-volume robots capable of moving by growing. Our biological models are plant roots and climbing plants. The plants' ability to grow will be translated by additive manufacturing processes inside the robot, which creates its body by depositing new materials with multi-functional properties, on the basis of the perceived external stimuli (without a pre-defined design). Energy efficiency will be intrinsic to such approach, but we are developing novel bio-hybrid energy harvesting solutions to generate energy by interfacing soft technologies with real plants. Perception and behavior are based on the adaptive strategies that allow plants to explore the environment.

The potential impact on society of plant-like self-creating robots could be huge and wide, e.g., in rescue, medical applications, space, or environmental monitoring. Since the design of these robotic solutions is deeply based on a few selected plant features, a new view of *robots for biology* can be envisaged, with the goal to give insights on the organisms themselves and open new exciting opportunities both in science and engineering.