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EDITORIAL

Soft component technology and application for soft robotics

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Conventional robots are constructed with rigid parts and materials, restricting their ability to deform freely and adapt to the external environment. Performing tasks such as handling delicate materials and navigating narrow pathways is challenging for these typical robots made of stiff materials. However, there is a growing demand for such functions in various industries. Recent advances in soft robotics have garnered considerable attention as solutions to these challenges. Soft robotic systems in various forms present a systematic solution for performing unique tasks. The goal of soft robotics research is to develop advanced technologies, incorporating innovative robotic mechanisms based on soft materials and structures to enhance adaptability. Soft robots find broad applications in diverse fields, including industry, healthcare, and field exploration.

Soft component technology plays a crucial role in configuring soft robots. Soft actuators introduce new types of motion and operation mechanisms, while soft sensors measure the deformation of the actuators with a tiny stiffness change. These advancements in soft actuators and sensors encourage researchers to explore new robotic designs and applications. Additionally, the component technology enables the integration of soft and typical robots into hybrid systems. Moreover, each soft component can extend its applications beyond robots to other electronic or mechanical systems.

This special issue establishes corner stones for the soft robots by providing scientific methods and technologies that contribute the realization as the components in the robots. This special issue on soft component technology and application for soft robotics presents eight papers that were selected by the guest editors, Youngsu Cha, Kwang Jin Kim, Seung-Won Kim, and Hyosang Lee, based mainly on the relevance and contributions to soft components for soft robots. The papers went through the normal multistage peer review process of the ISR journal.

Surgical robots play a crucial role in the application of soft robotics, with soft actuators representing a groundbreaking innovation in medical technology. In the article "Soft actuators in surgical robotics: a state-of-the-art review," authors provide a deeper understanding of the specificities of each actuator and the diverse range of soft medical robotic applications they have been applied to. This understanding is essential for comprehending the current state-of-the-art in specific applications utilizing different actuation mechanisms and for identifying the future challenges that these actuation technologies need to address for the further development of advanced soft surgical robots and the extension of their application range in robotic medical applications.

Soft robots also offer unique advantages in the field of rehabilitation due to their compliance, adaptability, and ability to interact safely with the human body. In "Pneumatic artificial muscle-based stroke rehabilitation device for upper and lower limbs," authors introduce a soft robotic device designed for flexion and extension assistance in both the elbow and knee joints. This device utilizes pneumatic artificial muscles with a unique construction, operating in two modes: continuous passive mode for repetitive limb movements and an active intent-based assisted mode that detects patient movement intentions through surface electromyography. Testing results show effective generation of muscle activity and range of motion for upper and lower limb rehabilitation in both

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modes. Additionally, in "Kinematics and stiffness analysis of a wheelchair-based cable-actuated ankle rehabilitation robot with flexure-based variable-stiffness devices," authors develop a cable-actuated wheelchair-based ankle rehabilitation robot with three degrees of freedom for each ankle joint. The proposed robot features redundantly actuated cables, allowing simultaneous adjustment of pose and stiffness. Safety during human–robot interactions is improved through a variable-stiffness device, designed for flexibility.

The importance of mobility in robotics lies in its ability to enable machines to navigate and traverse various environments. The size of the mobile robot limits the accessible environment: the robot cannot pass through a space smaller than its size. To explore environments containing gaps, holes, and crevices, a small-scale robot is necessary. In "Development of the sub-10 cm, sub-100 g jumping-crawling robot," authors propose a small scale jump-crawling robot. The proposed robot has crawling, jumping, and self-righting mechanisms. The combination of crawling and jumping allows the robot to overcome obstacles of various sizes. To reduce the weight and size of the robot, they employ a smart composite microstructures design method and utilize a shape memory alloy actuator.

New soft actuators and sensors are always welcome in robotic applications. In "Reinforced bidirectional artificial muscles: enhancing force and stability for soft robotics," author introduces a comprehensive investigation and experimental results of a reinforced bidirectional artificial muscles design. In "Enhanced flexible vibrotactile actuator based on dielectric elastomer with propylene carbonate" authors propose a flexible vibrotactile actuator based on a dielectric elastomer which is fabricated by mixing a PDMS-Ecoflex elastomer and propylene carbonate solution. In "Frontend and backend electronics achieving flexibility and scalability for tomographic tactile sensing," authors introduce an electronic design strategy dividing frontend and backend electronics for the resistance tomography-based tactile sensors. In "Detecting deformation of soft cylindrical structure using piezoelectric sensors," authors propose a model for the electrical responses of a soft cylindrical structure with shear deformations using piezoelectric sensors.

Finally, we appreciate all the authors for their contributions and enthusiastic cooperation to make this special issue valuable. We also show our gratitude to all the reviewers and editors of Intelligent Service Robotics. We hope that the readers enjoy the interesting outcomes in this special issue.