2021 IEEE RAS Seasonal School on Rehabilitation and Assistive Robotics Based on Soft Robotics

By F. Taffoni, Y. Hirata, M.J. Johnson, S. Mazzoleni, and L. Zollo

Robotics is a key enabling technology in the rehabilitation and assistive field: it supports clinicians in administering robot-assisted rehabilitation treatment by maximizing the residual capabilities of patients and reducing the long-term effects of traumatic events or diseases. It also helps improve patients' quality of life by favoring social and professional integration. In this scenario, soft robotics can play a paramount role, as demonstrated by the growing interest in the use of soft and deformable structures in the world of robotics for health care. Soft and deformable structures can be beneficial in the systems that interact with humans and deal with uncertain and dynamic task environments, such as object grasping and manipulation during activities of daily living, locomotion over different ground conditions, and physical contact with people. The development of an integrated technological approach, centered on soft robotics and focused on the patient, represents a breakthrough in

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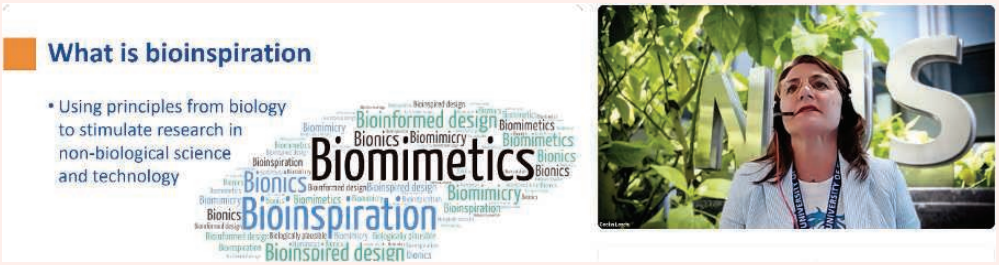
Figure 1. Some examples of robotic technologies demonstrated by the speakers: (a) the multijoint soft exosuit [1], (b) robotics for neurorehabilitation of lower limbs [2], and (c) a printable soft robotic hand. (Source: [3]; used with permission.)

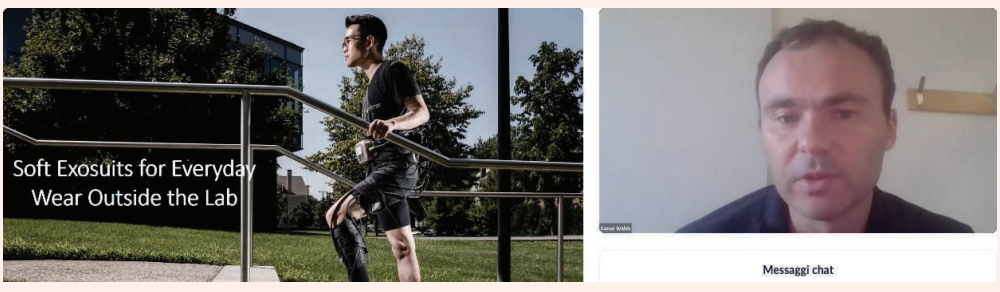
the rehabilitation and assistive domain and requires a new generation of trained people to address the new challenges it will raise.

The IEEE Robotics and Automation Society (RAS) Seasonal School on Rehabilitation and Assistive Technologies based on Soft Robotics (RAS SofTech-Rehab 2021) was proposed to focus on these challenges and bring together experts in the soft robotics and rehabilitation robotics fields to discuss them. It was organized by Università Campus Bio-Medico di Roma (Italy), in cooperation with Tohoku University (Japan), the University of Pennsylvania (United States), and Politecnico di Bari



(a)

(b)



(c)

(d)

Figure 2. (a) Cecilia Laschi (National University of Singapore) talks about bioinspiration and applications to the biomedical field. (b) Kyu Jin Cho (Seoul National University) presents tendon drive systems for soft wearable robots. (c) Conor Walsh (John A. Paulson Harvard School of Engineering and Applied Sciences) tackles the issues of lightweight and nonrestrictive exosuits for clinic, community, and workplace applications. (d) Christian Duriez and Hugo Talbot during their workshop on the Deformable Robotic Software platform for modeling, simulating, and controlling of deformable robots on the Simulation Open Framework Architecture.

(Italy). It was promoted by the RAS Technical Committee for Rehabilitation and Assistive Robotics and supported partly by the RAS Technical Education Program and partly by the European Future and Emerging Technologies-Open project SOMA. The main aim of the school, held virtually between 14 and 18 June 2021, was to provide young researchers with interdisciplinary knowledge about the design, control, simulation, and modeling of soft robotic systems for rehabilitation and assistance, to be used in clinical practice and to support activities of daily living.

SofTech-Rehab 2021 was conceived as an educational event that would both collect and disseminate technical information and help foster international cooperation among people from heterogeneous backgrounds. The program consisted of technical lecturers, virtual workshops, teamwork, and a final virtual competition. Figure 1 presents examples of some of the demonstrated technologies. There were 13 technical presentations [Figure 2(a)–(c)] given by speakers spanning six countries. The presentations covered topics in bioinspiration, material selection and fabrication techniques, soft mechatronic components (for actuation, control, and sensing), applications in health care (robot-assisted rehabilitation and assistive robotics), and future perspectives in soft robotics for rehabilitation and assistance, resulting in multiple articles in print and online. Representative examples include [1]–[3]. Four virtual workshops [Figure 2(d)] provided the participants with technical skills in modeling soft materials and robots. For each workshop, a list of assignments gave participants the possibility to further refine their skills with practical applications.

The seasonal school received 67 applications from 16 different countries: 60 students were accepted based on their experience and motivation. Twelve of them were RAS student members, about one third of them were female, and about 20% were traditionally underrepresented in the field of robotics. The students (Figure 3) worked in 12 international and heterogeneous teams to address a problem related to the rehabilitation and/or assistive domain using practical and theoretical knowledge developed during the school. Each group presented its developed idea with a PowerPoint presentation on the last day of the school in front of a competition committee. The three best teams were Musik, who proposed a tendon-actuated exoskeleton for scoliosis rehabilitation (Figure 4); Soft Club, who proposed a soft robot for neck stabilization; and Backscratchers, who presented a soft robotic arm for the assistance of people with disabilities. All the teams consisted of five participants with a multidisciplinary background from different universities all over the world.

One of the main goals of the school, aside from technical education, was to create synergy and a feeling of collaboration and complementarity among the variety of participants. Despite the strong limitation due to the pandemic situation, the feedback on the school collected through an on-purpose evaluation questionnaire clearly indicated an appreciation for the organization (mean score: 8.9/10) and described

Figure 3. Some of the 2021 SofTech-Rehab Seasonal School participants.

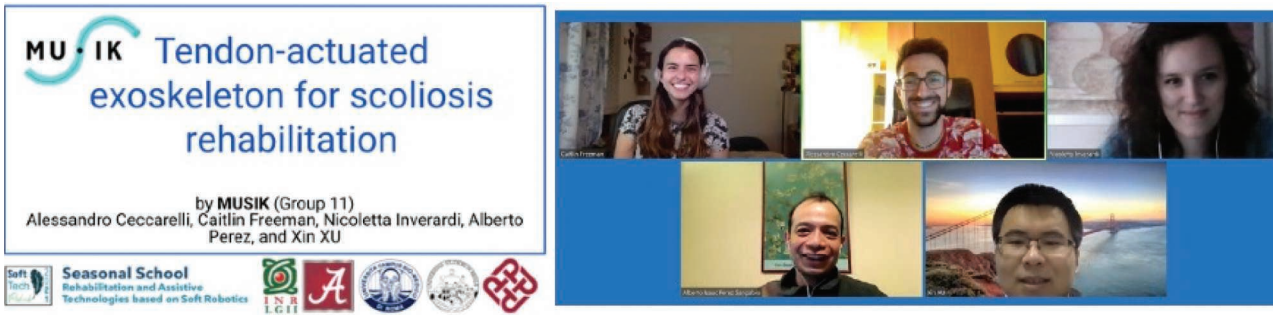


Figure 4. The SofTech-Rehab final competition. The group in first place proposed a tendon-actuated exoskeleton for scoliosis rehabilitation based on the four assignments of the four workshops.

the school and the teamwork as a successful experience (mean score: 8.4/10). There is now a clear desire to meet again through future seasonal schools and potentially new specialized conferences and workshops.

Acknowledgments

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