Robotics Responds to the COVID-19 Outbreak

By Lino Marques, Robin Murphy, Kaspar Althoefer, Satoshi Tadokoro, and Cecilia Laschi

The coronavirus pandemic has quickly become the most dramatic and disruptive event experienced by our current generation. The disease has spread very quickly around the world. The growing numbers of new infections and patients in need of intensive medical care have pushed clinical services beyond their limits, revealing a shortage of trained personnel and lifesaving equipment, such as ventilators. In addition, frontline health professionals operating in highly contagious areas expose themselves to the risk of infection. The most common political response to mitigate the spread of the disease has been to promote social distancing and locking down entire countries. Although effective, these measures impose heavy social and economic consequences.

Robotics progress has had an impact on the coronavirus pandemic, and, in turn, the pandemic has led to progress in robotics. The international robotics community engaged in this emergency at its very start and offered support with existing robotics technologies as well as by developing new devices and systems within short time frames. An analysis of how robotics can contribute to managing pandemics was proposed early on in the robotics community [1] The possibilities of using robots to replace humans and for remote operation in risky environments and tasks, as well as in proxying social interaction, have gained interest and value for potential help during the pandemic. Robotics and automation technologies are already playing a critical role in this crisis: while testing and life support equipment are usually automated, in the past months, we have seen human creativity emerge in the fight against this pandemic through the use of robots in applications never seen before, such as protecting people by disinfecting risky environments, detecting the disease, monitoring social distancing, providing remote care, promoting social interaction for confined patients, supporting remote work, and delivering medical supplies to hospitals and goods to persons at home or in hard to reach places, and so forth. These applications, which typically involve the deployment of robots in normal living environments, their operation by unskilled personnel, and the interaction with the general population, impose significant research challenges that need to be addressed and overcome. Additionally, the use of robots for the regulated fields of health care and for public safety, as well as for interaction with common citizens, raises ethical, safety, and reliability concerns that also need to be carefully considered.

This special issue of *IEEE Robotics and Automation Magazine*, edited by the IEEE Robotics and Automation Society Special Interest Group on Humanitarian Technologies (SIGHT), aims to present up-to-date results and innovative advanced solutions on the use of robotics and automation technologies to fight the outbreak, giving particular emphasis to works involving the actual deployment of robots combined with meaningful analysis and lessons learned for the robotics community. It collects nine articles that span reviews of current cases of robot applications in pandemics, specific cases of existing robots being deployed in COVID-19-related scenarios, and even cases involving the fast design and development of robotic devices to respond to this emergency.

The review article by Di Lallo et al. reports lessons learned and challenges faced by medical robotics in the context of the pandemic. It provides an extensive survey of medical robots used in different tasks, along with scenarios of prevention, screening, diagnosis, treatment, and home care. As a contribution to the robotics community, this article outlines unmet needs and open challenges to ensure preparedness to combat infectious diseases.

Covering a more specific area, the review by Courtney and Royall reports on the use of robotics in laboratories, addressing the whole workflow, from automated sampling acquisition and processing to the use of robots in the development of new medicines and vaccines. More broadly, Jovanovic et al. report on the first 10 projects, out of 146 proposals, funded by the European HERO Digital Innovation Hub on health-care robotics. These are industrial projects across Europe aiming to have a clinical impact within a two-month time frame.

Several of the articles report the use of mobile robots in the pandemic, both outdoors, for logistic tasks, and indoors, for disinfection, logistics, and telepresence for patients and health-care workers. Liu et al. describe the hardware and software architecture employed by the

Digital Object Identifier 10.1109/MRA.2020.3048866
Date of current version: 22 March 2021

Hercules autonomous vehicle, which was employed both for contact-less transportation of goods and for road disinfection in several Chinese cities. Tiseni et al. propose an irradiation physics-based path-planning algorithm for autonomous disinfection robots using ultraviolet type-C lamps. The algorithm was validated in several rooms with a differential drive mobile robot equipped with a tower of lamps. Tamantini et al. report on the two-month use of a commercial autonomous robot inside a COVID-19 treatment center in an Italian hospital. The robot could be adapted either for logistics support or for area disinfection. Ruiz-del-Solar et al. describe the telepresence Pudu robots, developed and deployed in just eight weeks. These robots have been used in two Chilean hospitals to facilitate communication between COVID-19 patients and health-care workers. More specific COVID-19-related tasks have also been addressed with robotic tools, such as the automatic robotic swab for throat testing described by Xie et al., which reduces contact with patients, and the open source, low-cost ventilator, designed and developed in only three weeks, as described by Gafford et al.

This collection of articles shows how the international robotics community has engaged in and responded to the COVID-19 pandemic in a relatively short time and how it can continue to evolve. It offers a thorough overview of the many ways robotics technologies can contribute to an emergency like the one brought by this infectious disease. Ultimately, the experiences described in this special issue provide an important contribution to the robotics community in terms of lessons learned and the challenges ahead.

Reference

[1] G. Z. Yang et al., "Combating COVID-19—The role of robotics in managing public health and infectious diseases," *Sci. Robot.*, vol. 5, no. 40, p. eabb5589, 2020. doi: 10.1126/scirobotics.abb5589.

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