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Cybathlon: How to promote the development of assistive technologies

Peter Wolf, Robert Riener

Assistive technologies have the potential to improve quality of life in countless ways. People with paralyzed or weakened limbs can use robotic exoskeletons to augment their strength and improve limb functions, whereas amputees can use powered prosthetic devices to successfully perform many activities of daily living. People with more severe motor impairments such as tetraplegia can use robotic wheelchairs to remain mobile even on uneven terrain or brain-computer interfaces (BCIs) to communicate with electronic aids and to control assistive devices or powered white ware without the need for physical activity.

Unfortunately, despite the large number of people with disabilities, current technologies lack functionality and usability, leading to poor acceptance and insufficient support during everyday activities. For instance, no commercially available wheelchair can climb stairs, most arm prostheses do not enable versatile hand functions, power supplies of many orthotic and prosthetic devices are limited, and the application of BCI systems is so cumbersome and inaccurate that they are not yet used outside the research laboratories (1). As part of an effort to promote the development of “useful” assistive technologies, ETH Zurich launched the Cybathlon. The first Cybathlon was held in Zurich, Switzerland, in October 2016 and consisted of a scientific symposium followed by a championship for athletes with motor impairments who competed in six different disciplines: We organized races with powered arm prostheses, powered leg prostheses, powered exoskeletons, powered wheelchairs, functional electrical stimulation (FES) bikes, and BCIs (1, 2).

Race tasks and tracks for the athletes were carefully planned not only to put existing technologies into place but also to encourage teams to develop novel technologies. One-third of the participating teams came from companies, whereas the remaining ones had an academic background. Indeed, the Cybathlon showcased advances in assistive technologies, their benefits, and their limitations. For instance, all participating teams in the powered wheelchair race presented hybrid designs combining wheels with either leg-like mechanisms or tracks to climb stairs. The athletes had to control the modes of the wheelchair, which also resulted in faulty usage so that one wheelchair did not come off the start. Thus, one remaining challenge of robotic wheelchairs is shared control between user and wheelchair. Such control will also allow users with limited neuromuscular or perceptual capabilities to benefit from robotic wheelchairs.

As another example, an arm prosthesis combining the advantages of body-powered and myoelectric systems was presented for the first time, which outperformed all myoelectric arm prostheses in the competition. However, the race was won with a body- powered prosthesis, highlighting that current myoelectric systems are still limited in reliable control. We have also seen a new exoskeleton that included ankle actuators to relieve the user of compensatory movements when walking over slopes or

climbing stairs. These and other technical advances are reported in two special issues (3, 4). In addition, eight case reports were presented about the developments showcased in the FES bike race (5).

At the Cybathlon 2016, 66 athletes from 56 teams and 25 nations demonstrated, in a comprehensive and entertaining manner, how people with disabilities can apply assistive technologies to overcome daily life challenges. The Cybathlon was attended by more than 4600 spectators in a sold-out indoor stadium (Fig. 1); of those, 283 participated in a brief survey about their experience. The majority (54%) were between 19 and 30 years old, and an additional 38% were between 31 and 60 years old. Among survey respondents, 51% attended because of interest in research and technology, whereas 27% attended because of interest in medical topics. When asked whether the Cybathlon fulfilled their expectations, 91% said that their expectations were fully filled or even exceeded. Thus, we believe that we successfully generated substantial public interest, especially among young people interested in technology.

The Cybathlon was effective from an outreach perspective, too. In addition to coverage from Swiss news agencies (the entire 8-hour championship was live broadcasted by the Swiss, Austrian, and German national broadcasters), 140 media representatives from 15 countries registered to cover the event. In the year 2016, over 500 articles were published about the Cybathlon in, for example, Financial Times, New York Times, Neue Zürcher Zeitung, Sports Illustrated, Spiegel, The Herald, Washington Post, Wired, and Yumiori Shimbun (6). Over 4500 video reports by teams, visitors, and media networks such as engadget (7) can be found online.

Encouraged by the positive press coverage, the positive responses of the teams and disability organizations, and the enthusiastic atmosphere in the stadium, the Cybathlon initiative is being continued and has become a worldwide platform for scientific exchange, technical development, and societal inclusion programs. Races at fairs and conferences promote the communication between people with disabilities, technology providers, researchers, and the general public. In addition, we bring Cybathlon to schools to reinforce discussions with well-known personalities with physical disabilities and to self-experience the latest assistive technologies. In this way, science and technology serve as a promoter of societal inclusion and break down mental barriers about people with disabilities. Cybathlon has already fostered the development of technologies that facilitate mobility and increase the quality of life while being accepted by the user.

The success story of Cybathlon 2016 has motivated us to organize another Cybathlon in May 2020 (8). The six disciplines and the general rules have been kept, but tasks have been adapted slightly to promote developments in terms of versatile applicability in daily lives. Already, 20 teams have registered more than 2 years before the next Cybathlon will take place.

We look forward to future Cybathlon- related activities. As the Cybathlon initiative grows, it will further promote the development of assistive technologies and facilitate the communication among the different stakeholders involved. Thereby, the initiative will tackle some of the grand challenges of Science Robotics such as new battery technologies, BCIs, and ethics and security (9). This will not only improve the quality of novel assistive devices but also the quality of life of people with severe motor impairments. Thus, Cybathlon will improve the inclusion of the people with disabilities in our society.

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