Robot Competitions: What Did We Learn?

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Figure 1. An illustration of 16th-century instruments that have been improved based on technological challenge prizes.

Competitions and challenge prizes have a long history as a high-impact tool for mobilizing human talent to find new solutions to societal problems and major technological achievements—read [1]–[3] for impact analysis and historical perspectives. According to [1], in 1567, the king of Spain established the Spanish Longitude Prize to discover a method to find longitude at sea. This is the oldest record of an inducement prize, with an amount of 6,000 gold ducats plus 2,000 ducats per year for life (Figure 1).

Competitions and prizes achieve innovative changes by influencing society or specific communities and individuals in different ways. The societal benefits include

- identifying excellence
- influencing public perception for a specific domain
- focusing communities on specific problems and mobilizing new talent
- strengthening problem-solving communities by educating individuals.

Competitions and challenge prizes provide valuable leverage for the prize investment by mobilizing financial or intellectual capital in support of a valuable challenge's solution. The leverage presents two flows: 1) a shift of the risk from the sponsors to participants since challenges attract investments of capital and time from motivated competitors and 2) when prizes produce scrutinized solutions, they can attract further investment in a particular field.

In the robotics community, as in many other scientific and technological domains, there has been a significant growth in the number of challenge prizes and competitions launched in recent years. The aim is to stimulate innovation more effectively, to meet a defined challenge, and to provide solutions to the problems that matter to roboticists and society.

The workshop "Robotics Competitions: What Did We Learn?," organized at the 2015 IEEE/Robotics Society of Japan International Conference on Intelligent Robots and Systems (IROS), was an opportunity for experts active in areas of applied robotics to review past robot competitions and to find out what can be learned from such competitions and to what extent these competitions underpin and further robot research. The workshop was useful to create guidelines for future robot competitions and explore how they can be improved so that tangible results useful for future research and technological development can be obtained. During the workshop, the speakers explored the synergies that will arise from robotic competitions for education, for the advance of modern robots and robotic technologies and/or to promote practical applications, such as rehabilitation, medical robotics, care of the elderly, search and rescue, or factories of the future.

The workshop addressed the following questions:

- What is the impact of robot competitions on robotics research?
- Is there evidence that robot competitions accelerate robot technology and innovation?
- Are robot competitions useful tools to train early career roboticists?
- Are robot competitions successful in bringing younger people to the field of engineering and robotics?
- Are robot competitions a good tool in promoting robotics to lay people/the public? Can more be done to improve on the current state?

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The workshop initiated a discussion with the RoboCup competition. RoboCup is one of the most well-known robotics competitions and was proposed by the artificial intelligence and robotics community in 1993. The first public event took place in Nagoya, Japan, during IJCAI'97 [4]. In 1997, RoboCup made its first steps toward the development of robotic soccer players that can beat a human World Cup champion team. The history of and key aspects for the development of RoboCup were presented by Manuela Veloso from Carnegie Melon University, Pittsburgh, Pennsylvania.

More recent robotic competitions foster scientific progress and innovation in robotics through the design and implementation of competitions for solving societal challenges and securing industrial competitiveness. That is the case of competitions such as RoCKIn [5], the European Robotics Challenges (EuRoCs) [6], and EuRathlon [7].

RoCKIn aims to foster scientific progress and innovation in cognitive systems and robotics. Pedro Lima from the Instituto Superior Técnico, University of Lisbon, Portugal, described and discussed how the RoCKIn challenges [5] are oriented toward indoor end-user scenarios, which catch the interest of both the general public and the scientific community.

The manufacturing industry needs competitive solutions to keep global leadership in products and services, and Rainer Bischoff from KUKA Laboratories GmbH, presented the lessons learned from EuRoCs [6] toward that aim.

euRathlon is an outdoor robotics competition that invites teams to test the intelligence and autonomy of their robots in realistic mock emergency-response scenarios [7]. Alan Winfield, from the University of the West of England, Bristol, United Kingdom, presented the lessons learned from the euRathlon trial for 2015.

Some robotic competitions concentrate more on technical challenges considered as critical for the advancement of robotic technologies and impact on society. This is the approach of the DARPA Robotics Challenge and, more recently, of initiatives such as CYBATHLON [8], the MBZ International Robotic Challenge (MBZIRC) [9], or Robots for Good [10].

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CYBATHLON is a competition that addresses athletes with disabilities [8]. The competition is a championship for pilots with disabilities who are using advanced assistive devices including robotic technologies. Dario Floreano, from the Advisory Board of

the competition, represented Robert Riener, the initiator and organizer of CYBATHLON.

Lakmal Seneviratne from Khalifa University, United Arab Emirates (UAE), presented the aims and goals for MBZIRC, a competition organized in Abu Dhabi, UAE, that will have the first event in February 2017 [9]. MBZIRC aims to provide an ambitious, science-based, and technologically demanding set of challenges in robotics and is intended to demonstrate the current state of the art in robotics in terms of scientific and technological accomplishments and to inspire the future of robotics. The first challenge of this prize is based on mobile robotic devices operating in dynamic environments for autonomous tasks for navigation, surveillance, and physical intervention.

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Europe is home to world-leading researchers and innovators who are uniquely well positioned to tackle the pressing issues society faces. Challenge prizes have a long history in Europe, with proven high impact for mobilizing talent to find new solutions to societal problems. The Horizon 2020 program for research and innovation, supported by the European Commission, is already pioneering the first five Horizon Prizes [11]. Emanuele Ruffaldi from Scuola Superiore Sant'Anna, Italy, described the activities of a set of proposals for the next generation of Horizon prizes in ICT [12].

This workshop was the first forum in a large IEEE international robotics conference (IROS 2015) where researchers and competition organizers provided a review of the major current approaches to robotic competitions, sharing common practices and exploring possible new approaches on the design and execution of such competitions.

Presentations and round-table discussions focused on obstacles and challenges and the future direction of robot competitions. The workshop acted as a platform for wider discussions and establishing guidelines/recommendations for future robot competitions. Topics such as robotic competitions toward research excellence and technology innovation, robotic competitions and education, and training early career roboticists were addressed in the workshop. There was general agreement about the benefits of robotic competitions to be used as hub for economic development; see details in [13].

References

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President's Message *(continued from p. 6)*

- international market and regulation of import and export.

Other fields of robotics and automation could have similar or different issues.

RAS is expected to advise and educate social stakeholders, engineers, and researchers but also business leaders, politicians, and media. Otherwise, these issues would not be appropriately resolved because many of the social stakeholders would not have accurate insight into future robotics on the basis of correct technical knowledge. The social system has to be designed carefully and wisely to embed robotics and automation into human life.

We, the top world leaders of robotics and automation, shall take a major role in realizing this innovation with profound wisdom and strong leadership to add a new page in the history of humanity. We are following the same trail as our forerunners—such as in the development of the automobile, communication technology, and computers—to accomplish the historical revolution.

Reference

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