Results of the IEEE RAS Standards Strategy Meeting

By Craig Schlenoff

O n 30 September 2018, the Industrial Activities Board (IAB) of the IEEE Robotics and Automation Society (RAS) organized a Standards Strategy Meeting in conjunction with the Intelligent Robots and Systems conference in Madrid, Spain. The goal of the meeting was to review and refine the overall robotics standards landscape to determine areas of robotics standards development that RAS should focus on and areas in which the Society should partner with other standards development organizations. Attendance was limited to 15 people (due to room size and the desire to make it a focused meeting). Attendees included many of RAS's working group chairs; representatives from the International Organization for Standardization (ISO), Robotic Industries Association (RIA), and American Society of Mechanical Engineers (ASME); and experts in various robotics fields including autonomous vehicles and industrial robotics (Figure 1).

The meeting started with presentations by the participants to provide context and then moved on to a discussion of RAS's role. A summary of the presentations (in the order in which they were presented) follows.

- "Welcome/Overview/IEEE CORA Standard"
  - Presenter: Craig Schlenoff, associate vice president of standardization in RAS

Figure 1. The strategy session attendees.

- Summary: This presentation provided an overview of the meeting's goals, the agenda, a description of existing IEEE RAS standards, and a detailed description of IEEE Standard 1872, *Core Ontologies for Robotics and Automation* (*CORA*). Key characteristics of *CORA* are:
  - standardized in April 2015
  - developed by 175 members representing a good cross section of industry, government, and academia
  - won the IEEE Standards Association (SA) Emerging Technology Award and was mentioned in President Obama's "The National Artificial Intelligence Research and Development Strategic Plan."
- "IEEE P1872.1 Robot Task Representation"
  - Presenter: Stephen Balakirsky, P1872.1 Working Group chair
  - Summary: This presentation described the P1872.1 Robot Task

Representation Working Group's efforts, which started in February 2017. The goal is to develop a knowledge representation that addresses robot task structure, decomposed into subclasses, categories, and/or relations. It includes attributes, both those common across tasks and those specific to particular tasks and task types. With this, one would be able to provide a common means of representing tasks across domains and subdomains, addressing both the relationships between tasks and platforms and the relationships between tasks and users.
- "IEEE P1872.2 Autonomous Robotics Ontology"
  - Presenter: Veera Ragavan, P1872.2 Working Group member
  - Summary: IEEE Standard P1872.2, *Autonomous Robotics Ontology*, is a logical extension of IEEE Standard 1872, which focuses on autonomous robotics, including general

ontological concepts and specific axioms as well as use cases. The group has already addressed the development of an underlying architecture and the definition of key vocabulary terms, and it is in the process of developing ontological concepts to formally define the vocabulary.

- "IEEE P2751 3D Map Representation"
  - Presenter: Francesco Amigoni, P2751 Working Group chair
  - Summary: The presentation described the existing IEEE Standard 1873, *Robot Map Data Representation for Navigation*, which provides a specification for representing XML-based 2D metric and topological maps to facilitate the exchange of map data among robots, computers, and other devices. It also described the new P2751 3D Map Data Representation Working Group, which is extending IEEE Standard 1873 to focus on 3D maps, including point clouds, grids such as voxel maps, and polygonal meshes.
- "Ethics in Technology"
  - Presenter: Ali Hessami, chair and technical editor of the IEEE P7000 standards
  - Summary: This presentation provided an overview of ethics as a whole and described the IEEE P7000 standards. The purpose of these standards is to create a shared mission around values, value priorities, and value harms that should be avoided as well as to ensure value-based system engineering by building a bridge between the value mission and the actual development of a system. A working group draft was expected in October 2018.
- "IEEE RAS/SA 7007—*Ontological Standard for Ethically Driven Robotics and Automation Systems*"
  - Presenter: Sandro Fiorini, vice chair of the IEEE 7007 Working Group
  - Summary: This presentation described the IEEE Standard 7007 effort focusing on ethically driven robotics. The standard

establishes a set of definitions and their relationships that will enable the development of robotics and automation systems in accordance with worldwide ethics and moral theories, with a particular emphasis on aligning the ethics and engineering communities to understand how to pragmatically design and implement these systems in unison. The standard describes what is meant when one says that something is "ethical" or "not ethical."

- "Intro to P2730"
  - Presenter: Tamas Haidegger, IEEE RAS IAB associate vice president
  - Summary: This presentation described IEEE Standard P2730, *Classification, Terminologies, and Definitions of Medical Robots*, which RAS is cosponsoring with the IEEE Engineering in Medicine and Biology Society. RAS joined this effort in September 2018. The standard specifies the categorizing, naming, and definition of medical robots. The group is in the process of changing its name to *Medical Electrical Equipment Employing Robotic Technology Terminology and Classification.*
- "ISO and RIA Efforts in Standardization"
  - Presenter: Roberta Nelson Shea, global technical compliance officer at Universal Robotics, ISO Technical Committee (TC) 299 Working Group 3 convenor, ISO TC299 Study Group 1 convenor, and American National Standards Institute (ANSI) Robotics Industry Association (RIA) standards chair emeritus
  - Summary: This presentation described ISO TC299 (Robotics), whose goal is to develop high-quality standards for the safety of industrial and service robotics to enable innovative robotic products to be bought onto the market. These standards are mostly harmonized standards for Europe, North America, and Asia. They tend to have very good global acceptance and are used for

asserting conformity in a variety of regions around the globe. Specific efforts include Study Group 1 (Gaps and Overlaps), Working Group 1 (Vocabulary and Characteristics), Working Group 2 (Personal Care Robots), Working Group 3 (Industrial Safety), Working Group 4 (Service Robots), joint Working Group 5 (Medical), and Working Group 6 (Modularity for Service Robots). ANSI/RIA efforts were also discussed, including R15.06 (Industrial Robots and Robot Systems) and R15.08 (Mobile Robots). The scope of ISO TC299 excludes toys and defense (military).

- "ASME Robot Standards Efforts"
  - Presenter: Angel Guzman Rodriguez, Standards and Certification project engineer, Standardization and Testing Department
  - Summary: This presentation gave an overview of ASME and described the robotics field as one of the five core technologies that ASME wants to focus on in the future. Specific efforts will explore robot arms under the Standards Committee on Manufacturing and Advanced Manufacturing. They also have a new committee on mobile unmanned systems for inspection, monitoring, and maintenance of industrial facilities and power plants. A few other related efforts were also described.
- "Robot Standardization: Personal Care, Medical, and Modularity"
  - Presenter: Gurvinder Virk, technical director, InnotecUK (among other affiliations)
  - Summary: This presentation described the changing world of robotics, from industrial to service to modularity, as well as the growing safety requirements for closer human–robot interaction and the growing international standardization efforts for emerging robots. It also described how robots are changing from tools to assistants to servants and, most recently, to companions. Because

of this, even the definition of *robot* is evolving. Finally, it described the various working groups in the ISO, filling in some areas that were not fully covered in Roberta Nelson Shea's talk.

- "Thoughts on Autonomous Vehicle Robot Standards"
  - Presenter: Chris Debrunner, Lockheed Martin autonomous systems fellow
  - Summary: Dr. Debrunner led a discussion on autonomous vehicle technology and what is needed. The focus was on validation of autonomous systems (especially those that learn) and interoperability among vehicles and between vehicles and the environment. He described some autonomous vehicle work performed at Lockheed Martin that was built on the Robot Operating System.
- "A Perspective on Robot Standards"
  - Presenter: Henrik Christensen, director of the Contextual Robotics Institute
  - Summary: This presentation gave a high-level overview of the standardization process, with a focus on answering the following questions:
    - Why are we standardizing? (It is all about money.)
    - Who are the players? (Industrial companies, trade organizations, etc.)
    - When can we standardize? (Technology maturity, incentive, longevity.)

Some of the main takeaways were the need to leverage technology road maps where they exist, create a clear business case, and ensure collaboration among mature organizations. The presentations can be found at http://www.ieee-ras.org/industry-government/standards/standards-strategy-meeting.

After the presentations, a discussion ensued to determine the areas in which RAS could have the biggest impact on the robotics standards community while complementing the efforts of the other standards organizations. A few key areas were identified, including the following (in no particular order):

- *Harmonization of terminology among the various standards organizations*: The same term can be defined differently in different standards organizations and even among different groups within the same standards organization. RAS could play a valuable role in harmonizing these definitions.
- *Interoperability standards*: RAS has already started down this path with the *CORA* and *Robot Map Data Representation for Navigation* standards. No other standards organization appears to be focusing on this area. This would involve clear terminology definition and, possibly, interface standards.
- *"Under the Cover" standards*: ISO/TC 299 is working in the here and now. Forward-looking activity is not focused on the far future because standards are written to address known demand and need. Participants tend to be weighted toward industry representatives, manufacturers, integrators, and users. In contrast, the IEEE appears to focus more on the research side, with close ties to R&D and academia. A partnership could be mutually beneficial.
  - Electronic, electrotechnical, software, and hardware techniques and innovations could be leveraged for commercial applications. Roberta Nelson Shea mentioned that ISO/TC299 Working Group 3 does not dictate how to design or implement a solution; instead, the standards state the required end goal of the performance.
- *Verification of autonomous systems*: This is a growing research area, especially focusing on systems that learn. RAS could be a good home for standards and performance metrics to help verify autonomous system performance.
- *Robot agility performance metrics*: Because robots must adapt to ever-changing environments, metrics and test methods are needed to assess their agility performance when confronted with unexpected situations.
- *Human–robot interaction performance metrics*: As human–robot collaboration becomes more prevalent, metrics and test methods are needed to assess the interaction between the human and the robot, considering human factors and the transfer of information. (Note that this is distinct from robot–human contact and the topic of biomechanical limits, forces, speeds, and similar areas, which are already being addressed in ISO/TC199.)

As a direct result of the meeting, two study groups were proposed and accepted. The first will focus on verification of autonomous systems (led by Signe Redfield from the Naval Research Laboratory, Washington, D.C.); the second will focus on robot agility performance metrics (led by Anthony Downs from the National Institute of Standards and Technology, Gaithersburg, Maryland).

RAS could be a good home for standards and performance metrics to help verify autonomous system performance.

Both study groups will hold meetings at the 2019 International Conference on Robotics and Automation (ICRA2019) in Montreal, Quebec, Canada. In addition, a follow-up meeting is planned on the day before ICRA2019 (Sunday, 19 May 2019) to further the discussion that occurred during the standards strategy meeting. If you are interested in attending any of these meetings, please contact Craig Schlenoff at craig.schlenoff@nist.gov.