Standardisation Newsletter

Standardisation Efforts on Industrial and Service Robots

Standardisation is an important factor to pave the way onto the market for new and innovative robotic products and to foster market growth. While safety standards form the basis to establish a robotic product on the market, other standards can help to dismantle trade barriers. Standards on terminology and coordinate systems as well as ontologies improve communication between manufacturers, suppliers and end users and are first steps towards exchangeable robot components. In a few years, more standards on robot modularity can be expected that will help making robot systems modular and highly interchangeable. Further initiatives have started to create standards for benchmarking robot performance, making complex robot abilities measurable with the goal to increase market transparency.

As the market for service robots constantly grows, the demand for standards in this area also constantly rises. Due to the large variety of service robot designs and application domains, existing and newly developed standards usually do not cover all service robots but are limited to certain environments and robot types. Different standardisation organisations have adopted different approaches to fill the existing gaps. As an effect, several new standardisation working groups have formed in ISO, but also in other standardisation organisations. The working groups are open to all interested stakeholders from industry, academia and general society including manufacturers, integrators and professional end users.

This newsletter sums up the recent developments in robot standardisation with a focus on ISO activities.

Robot-related standardisation at ISO

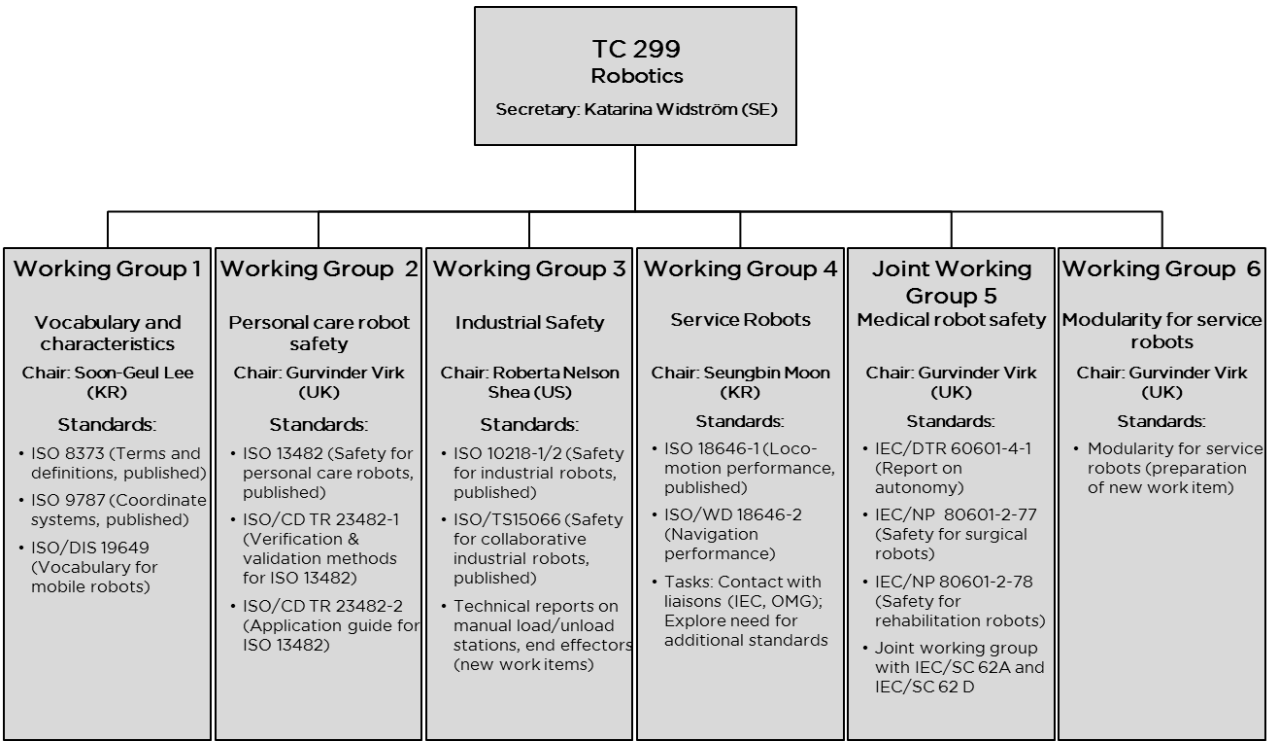

Fig. 1 Current structure of ISO TC 299

In 2016, the ISO subcommittee SC 2 "Robots and robotic devices" under the technical committee TC 184 "Industrial Automation" has been upgraded to a TC of its own (now TC 299 "Robotics"). This not only underlines the importance of standardisation for the robotic sector but also shows that robots are not limited to industrial automation any more. The new structure strengthens the standardisation initiatives for service robots and allows an easier forming of liaisons with other technical committees. The committee consists as before of six working groups dealing with different aspects and domains of standardisation (see Fig. 1). However, the upgrade to a TC has paved the way to perform further restructuring and founding of additional working groups in the future.

Nations that are currently actively participating in developing these standards are Canada, China, Denmark, France, Germany, Japan, the Netherlands, South Korea, United Kingdom and the United States. The working groups usually meet three times a year, in turns in North America, Europe and Asia. Meetings of the committee TC 299 plenary are held every one and a half years. Working groups are open for all motivated contributors. Experts are explicitly encouraged to participate (see below for more information how to get involved).

Standards are developed through the instrument of "commenting": During balloting periods, each national standardisation organisation has the possibility to submit comments proposing to change, delete or add text to the respective standard. In the international meetings, these comments are resolved in discussions and agreed changes are applied to the document. Further information regarding the different working groups is available on the ISO website[1] and the committee website[2].

[1] www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=5915511

[2] www.robotstandardisation.org

Fig. 2 Current structure of ISO TC 299

Progress in WG 1 – Vocabulary and characteristics

Chair: Soon-Geul Lee (Kyung Hee University, South Korea)

Standards:
- ISO 8373 – Robots and robotic devices – Vocabulary (published in 2012)
- ISO 9787 – Robots and robotic devices – Coordinate systems and motion nomenclatures (published in 2013)
- ISO/DIS 19649 – Robots and robotic devices – Vocabulary for mobile robots (draft international standard)

WG 1 is maintaining robot-related definitions and terminology which are used in the different working groups in TC 299. Fundamental definitions are the terms "robot", "robotics", "robotic technology" and "autonomy" which are used in the title and scope of the standardisation committee. As especially the market for service robots is still emerging, these definitions are not considered to be final, but will be adjusted from time to time as necessary and documented in future editions of the vocabulary standard ISO 8373. Apart from basic terminology, WG 1 is dealing with other vocabulary for certain domains such as navigation or perception. In addition, an existing standard on coordinate systems for industrial robots ISO 9787 has been revised and extended by coordinate systems for mobile service robots.

During the last meeting in Oxford, the DIS balloting results of ISO 19649 have been discussed and last changes were applied. In the next month, the ballot for the “final draft international standard” will start, which is the last balloting stage before publication. The standard defines terminology for mobile robots such as the definitions of wheel types and undercarriage structures.

Progress in WG 2 – Personal care robot safety

Chair: Gurvinder Virk (CLAWAR Association, United Kingdom)

Standards:
- ISO 13482 – Robots and robotic devices – Safety requirements for personal care robots (published in 2014)
- ISO/CD TR 23482-1 –Technical report: Validation criteria for personal care robots (committee draft)
- ISO/CD TR 23482-2 – Application guide for ISO 13482 to be published as a technical report (committee draft)

WG 2 has the task to develop safety standards for "personal care robots" – earthbound robots in direct interaction with the human and contributing directly to his/her well-being. Three robot types representing the personal care robot, "mobile servant robots", "person carrier robots" and "physical assistant robots" were identified and serve as examples in the standard ISO 13482.

Currently, the working group is developing two guidance documents which will help manufacturers to apply the standard and to verify compliance of their products. In the technical report ISO TR 23482-1 that is currently under preparation, verification and validation measures are described which can be used by robot manufacturers for safety testing. Tests include stability tests for different travel patterns (e.g. on ramps or while accelerating or stopping), but also impact tests with crash test dummies. A second technical report, ISO TR 23482-2, provides guidance on how to perform risk assessment and risk reduction for personal care robots. During the last meeting in Oxford, the working groups has mainly worked on risk assessment examples, which will be included in ISO TR 23482-2.

In the coming years, WG 2 will discuss a possible extension of ISO 13482 to a standard family with separate standard parts for each robot types. This would allow to provide more detailed requirements for each robot type as well as to extend the scope of ISO 13482 to additional robot domains.

Progress in WG 3 – Industrial safety

Chair: Roberta Nelson Shea (Rockwell Automation, USA)

Standards:
- ISO 10218-1 – Robots and robotic devices – Safety requirements – Part 1: Robots (published in 2011)
- ISO 10218-2 – Robots and robotic devices – Safety requirements – Part 2: Robot systems and integration (published in 2011)
- ISO TS 15066 – Robots and robotic devices – Safety requirements for industrial robots – Collaborative operation (published in 2015)
- Technical report: Safety requirements - Industrial robot system – manual load/unload stations (new work item)
- Technical report: Safety requirements for industrial robots – end effectors (new work item)

WG 3 has recently published the technical specification ISO TS 15066 which provides extended requirements for human-robot-collaboration and specifies limits for impact forces and pressures which might lead to an injury in case of collisions. Values are taken from medical literature/forensics as well as from practical tests on pain tolerance levels. After ISO TS 15066 had been finished, WG 3 started two new work items. One is a technical report on the safety of manual load stations, i.e. stations where a worker hands over a part directly to a robot end effector (e.g. a gripper). In addition, a guidance document will be developed on the safety of industrial robot end effectors.

As the current editions of ISO 10218-1 and -2 have now reached an age of 5 years, WG 3 will also soon start with the rotational review of these standards. During the update process, it is intended to integrate content from ISO TS 15066 into these standards.

Progress in WG 4 – Service robots

Chair: Seungbin Moon (Sejong University, South Korea)

Standards:
- ISO 18646-1 – Robots and robotic devices – Performance criteria and related test methods for service robot – Part 1: Locomotion for wheeled robot (publication by the end of 2016)
- ISO/WD 18646-2 – Robots and robotic devices – Performance criteria and related test methods for service robot – Part 2: Navigation (working draft)

Add. Task: Determining need for additional standards for service robots

WG 4 is engaged in developing standards on robot performance. These standards will define test methods, which allow to benchmark functions like path-finding, object recognition or the ability to move on difficult terrain. The first standard, ISO 18646-1 for measuring locomotion performance, has recently passed the final balloting stage and is now being published. A second part, ISO 18646-2 on navigation performance is currently under preparation and will include e.g. test setups for measuring path repeatability of the turning width of a mobile robot. During the last meeting in Oxford, a possible third part addressing grasping performance was discussed.

In addition, WG 4 has since many years the special task to monitor the development on the service robot market in order to identify the need for additional standards for service robots. In the last years, several liaisons have been established with IEC, because the development of standards for autonomous vacuum cleaners and lawn-mowers has been initiated there.

Progress in JWG 5 – Medical robot safety

Chair: Gurvinder Virk (CLAWAR Association, United Kingdom)

Standards:
- IEC/DTR 60601-4-1 – Medical electrical equipment – Part 4.1: Guidance and interpretation – Medical electrical equipment and medical electrical systems employing a degree of autonomy (close to publication)
- IEC/NP 80601-2-77 – Medical Electrical Equipment – Part 2-77: Particular requirements for the basic safety and essential performance of medical robots for surgery (new work item)
- IEC/NP 80601-2-78 – Medical Electrical Equipment – Part 2-78: Particular requirements for the basic safety and essential performance of medical robots for rehabilitation, compensation or alleviation of disease, injury or disability (new work item)

JWG 5 is a joint working group in cooperation with IEC/SC 62A and IEC/SC 62D. The group has spent several years on evaluating requirements for new standards on the safety of medical robots. In the next months, a technical report providing guidance on medical equipment with autonomous functions, ISO 60601-1-4 will be published.

In 2015, two subgroups have been founded inside JWG 5. The first subgroup has started developing a standard for basic safety and essential performance of robots for surgery, IEC 80601-2-77[3]. The second subgroup is dealing with medical robots used for rehabilitation and has recently started the development of IEC 80601-2-78. During the

[3] IEC/NP 80601-2-77 – Medical electrical equipment – Part 2-77: Particular requirements for the basic safety and essential performance of medical robots for surgery

last meeting in Oxford, both subgroups continued to gather material for a first draft of their standards. In particular, it was discussed, how risk reduction measures performed according to the machinery directive could be rated under the medical device directive.

Progress in WG 2 – Personal care robot safety

Chair: Gurvinder Virk (CLAWAR Association, United Kingdom)

Co-Chairs: Shuping Yang (RIAMB, China), Hongseong Park (Kangwon National University, South Korea)

Standard: Modularity for service robots (new work item)

WG 6 has the task to prepare the development of a new standard for interoperability and reusability of robotic components on mechanical, electrical and software levels. WG 6 is currently working on its first work item to create safety requirements and guidance for service robot modularity. Key sections being developed include

- Definitions
- Generic modularity issues (including connectivity, inter-operability and safety at the module level)
- Framework for hard- and software
- Key robotic components

During the last meeting in Oxford, the working group continued to work in a first draft of the new standard. It is intended that this draft is formally established as a new work item by the end of 2016.

Robot-related standardisation at IEC

While ISO has concentrated all standardisation activities for robots and robotic devices in one technical committee, IEC is developing robot-related standards in the technical committees (TC) that reflect the application domains of the robotic products. Having a strong focus on household appliances, IEC has in the last years developed standards on safety and performance measurement of robotic vacuum cleaners and lawn mowers.

In TC 59[4] "Performance of household and similar electrical appliances", various standards for vacuum cleaners have been developed in the past. In the last years, work on a new standard IEC 62849[5] has been started that comprises performance evaluation methods for "mobile household robots", robots that move in the household and perform intended tasks. The document has recently reached the status of a final draft international standard and will be published in the next months. The standard focuses on robots with the typical shape and abilities of a vacuum cleaning robot.

[4] IEC TC 59 „Performance of household and similar electric appliances": http://www.iec.ch/tc59.

[5] IEC/CD 62849 – Performance evaluation method of mobile household robot.

In TC 116 "Safety of motor-operated electric tools"[6], standards for electrical lawn mowers are developed and maintained. Based on safety requirements for non-robotic lawn mowers, a safety standard for robotic lawn mowers is currently under development[7] and will most likely be published in the coming year.

Possibilities to get involved in standardisation work

For the European academia/research and industry, it is crucial to participate in all standardisation working groups with a sufficient number of technical experts. Only by doing so, innovations and products will be considered during the standardisation process and latest research results can be incorporated in the standard. So we kindly ask you to consider participating in the standardisation process!

Encouragement to attend international meetings

Technical experts, who attend international meetings, vote in international balloting procedures and submit comments to propose changes in the documents, are appointed by the national standardisation organisation of their respective country. In order to get nominated, interested persons from industry or research institutes should contact their national standardisation body to ask for details.

Apart from formal contribution as a technical expert, it is also possible to visit a meeting as an observer. Observers are also formally appointed by national standardisation organisations, but do not have the right to participate in official balloting.

The next international meetings are planned as follows:

- November 7th to 18th, 2016: Subsequent meetings of WG 1-6 and TC 299 plenary in Orlando, Florida, Unites States
- February 6th to 17th, 2016: Subsequent meetings of WG 1-6 in Busan, South Korea

If you need assistance to get in contact with the standardisation working groups, do not hesitate to contact Theo Jacobs (theo.jacobs@ipa.fraunhofer.de).

Contributing to national mirror committees

When several experts from one country participate in standardisation, a national mirror committee may be formed. In these national committees, homework and comments for the international meetings are coordinated and results from the international meetings are disseminated to the national community. Even if no mirror committee has been formed yet, it is possible for interested technical experts to contribute to standardisation on a national level without attending the international meetings, for example by making comments for an international balloting.

[6] IEC TC 116 "Safety of motor-operated electric tools": http://www.iec.ch/tc116.

[7] IEC/CDV 60335-2-107 – Household and similar electrical appliances – Safety – Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers.

Benefit from travel cost subvention

The EU-funded coordination action RockEU 2 offers the possibility to reimburse travel costs to meetings for interested first-time visitors from a European country. If you are interested to join an international meeting, please contact Theo Jacobs (theo.jacobs@ipa.fraunhofer.de). It is obvious that only a long term engagement in these standardisation efforts is beneficial for the WG and/or the participants.

European Topic Group on Standardisation

Within the euRobotics AISBL, "Topic Groups" is a community-driven instrument to coordinate the activities in specific sub-domains of robotics. The objective of such a topic group is to support the launch of tangible "project proposals" by members of the European robotics community (be they member of euRobotics AISBL or not), but, first and foremost, to prepare the roadmap and project calls that precede such proposals.[8]

In 2014, a topic group on standardisation was created[9]. The topic group coordinates activities and collects input from the EU robotics community (academia and industries and SME) in order to convey the EU point of view into ongoing working groups in ISO committee TC 299 and also in order to create new ISO working groups where this seems necessary. The topic group is headed by Professor Gurvinder Virk who is also the chairman of the ISO working groups WG 2, JWG 5 and WG 6. Current areas of interest of the topic group are industrial robot safety, surgical robot safety, service robot modularity and robotic marine system safety and regulations.

The topic group on standardisation is currently putting the accent on modularity issues and related standardisation, both for software and hardware with the goal to complement the activities in the newly founded ISO working group on modularity. Key questions being discussed are how and with which concepts modularity can be ensured in the future and what role existing middleware frameworks (OPROS, OROCOS, ROS, ROS-Industrial, etc.) should play.

Another important work item is the safety of marine robots. The TG has started ongoing relationships with the SARUMS, a working group on Safety And Regulations for Unmanned Maritime Systems funded by the European Defence Agency that has the scope of creating European Guidelines applicable also to the civil sector. With the help of the CEN-CENELEC Management Centre, the topic group is exploring suitable standardisation actions which could result from the SARUMS' work.

The topic group members meet in person at least three times a year on the occasion of euRobotics topic group meetings and on the occasion of major robotics venues that, i.e. the euRobotics Forum, ICRA, IROS, etc. On conferences such as IROS, usually workshops on standardisation are organised by the topic groups which are open to all interested participants.

[8] Topic Groups: http://www.eu-robotics.net/ppp/objectives-of-our-topic-groups/

[9] List of euRobotics Topic Groups (as of August 23th , 2015): https://eu-robotics.net/cms/upload/List_of_Topic_Groups_without_contacts_August2015.pdf

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