

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. Safety standards form the basis to establish a robotic product on the market and reduce legal risks for manufacturers. Other standards can help to dismantle trade barriers such as standards on terminology, coordinate systems, benchmarking and modular design.

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. These 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

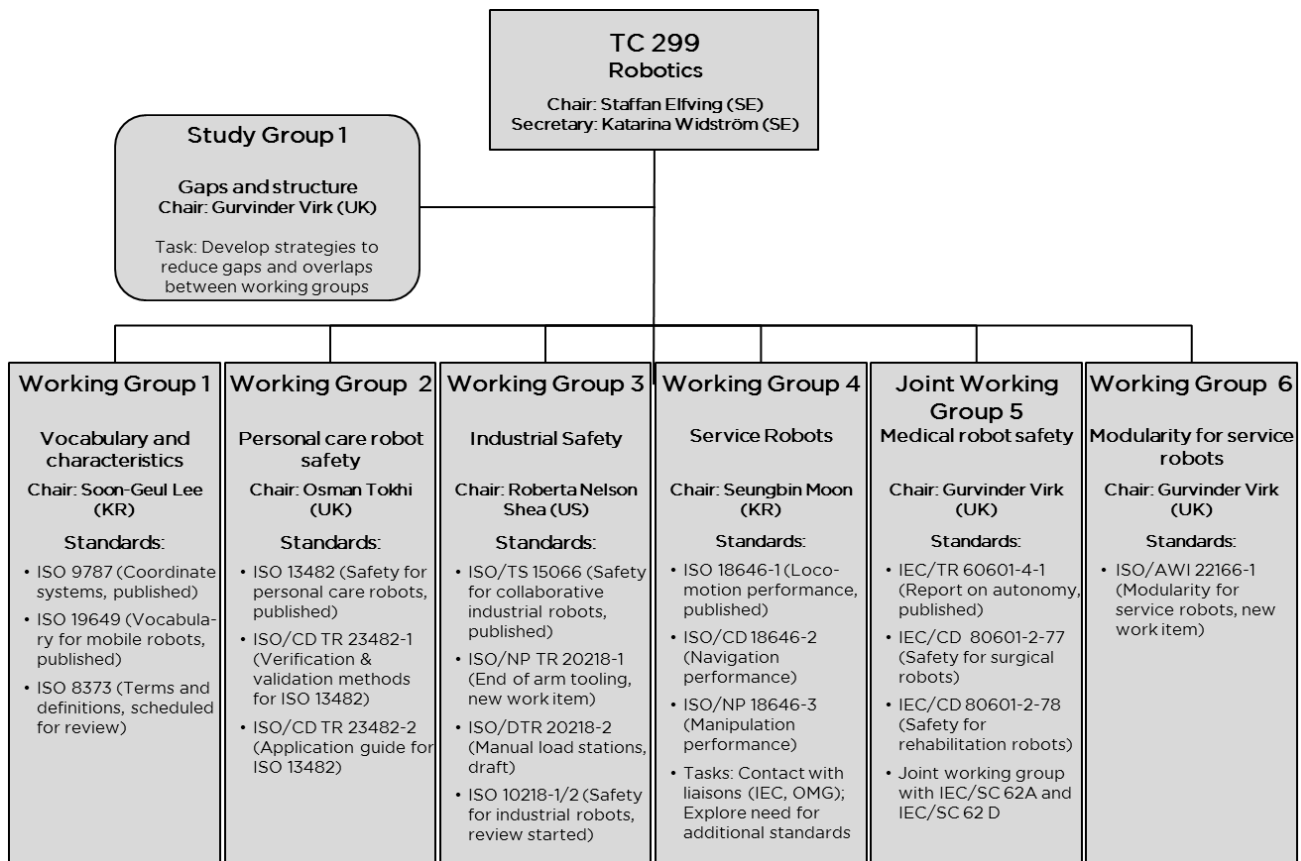


Fig. 1 Current structure of ISO TC 299

In 2016 ISO recognized the importance of standardisation in the field of robotics and established ISO TC 299 “Robotics”, which had formerly been a subcommittee of a TC on industrial automation, as a separate TC. Since this time the standardisation committee continued its work in six working groups (see Fig. 1), but has also started a strategical process with the goal to develop concepts, how the increasing demand of standards can be satisfied in the future.

Nations that are currently actively participating in TC 299 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.

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 website¹.

¹ <https://www.iso.org/committee/5915511.html>

Progress in WG 1 – Vocabulary and characteristics

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

- Standards:
- ISO 9787 – Robots and robotic devices – Coordinate systems and motion nomenclatures (published in 2013)
 - ISO 19649 – Robots and robotic devices – Vocabulary for mobile robots (published in 2016)
 - ISO 8373 – Robots and robotic devices – Vocabulary (published in 2012, scheduled for periodic review)

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. With the recently initiated review process of ISO 8373, WG 1 will coordinate a systematic review of the definitions with the goal to ensure that the terminology is fit for future standards and working groups. This will also include a categorisation of robots based on their mechanical structure, task and application domain which will allow the exact shaping of scopes for standards and working groups.

Apart from basic terminology, WG 1 is dealing with other vocabulary for certain domains such as navigation or perception and has published ISO 19649 in the beginning of 2017. The standard defines terminology for mobile robots such as the definitions of wheel types and undercarriage structures.

During the last meeting in Budapest WG 1 continued its work on the categorisation of robots and took first steps for the revision of ISO 8373.

Progress in WG 2 – Personal care robot safety

Chair: Osman Tokhi (London South Bank University, 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. With respect to the special situation that personal care robots act in direct vicinity of the user and that the autonomy of these robots is generally high, some clauses were added, that are unique in machinery safety, such as instructions dealing with incorrect autonomous actions and decisions.

During the last meeting in Budapest, the working group continued 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, measures for verification and validation 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.

When these two technical reports are published, WG 2 will start the systematic review of ISO 13482. Most likely this will include splitting up the standard into several parts, so that each robot type can be maintained in a separate document and new robot types can easily be added.

Progress in WG 3 – Industrial safety

Chair: Roberta Nelson Shea (Universal Robots Inc., USA)

Standards:

- ISO 10218-1 – Robots and robotic devices – Safety requirements – Part 1: Robots (published in 2011, periodic review started)
- ISO 10218-2 – Robots and robotic devices – Safety requirements – Part 2: Robot systems and integration (published in 2011, periodic review started)
- ISO TS 15066 – Robots and robotic devices – Safety requirements for industrial robots – Collaborative operation (published in 2015)
- ISO/NP TR 20218-1 – Robots and robotic devices – Safety requirements for industrial robots – Part 1: Industrial robot system end of arm tooling (end-effector) (new work item)
- ISO/DTR 20218-2 – Robots and robotic devices – Safety requirements for industrial robots – Part 2: Industrial robot system manual load stations (committee draft)

WG 3 is dealing with the safety of industrial robots. After the technical specification ISO TS 15066 which provides extended requirements for human-robot-collaboration and specifies limits for impact forces and pressures, 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 is developed on the safety of industrial robot end effectors.

WG 3 has recently started a systematic review of ISO 10218-1 and -2 which have now reached an age of 5 years. 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/CD 18646-2 – Robots and robotic devices – Performance criteria and related test methods for service robot – Part 2: Navigation (committee draft)
- ISO/NP 18646-3 – Robots and robotic devices – Performance criteria and related test methods for service robot – Part 3: Manipulation (new work item)

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

WG 4 is engaged in developing standards on robot performance. In order to compare the performance of functions like path-finding, object recognition or the ability to move on difficult terrain, standardised test methods are necessary. The first standard, ISO 18646-1 for measuring locomotion performance, was published in 2016. The second part, ISO 18646-2 on navigation performance has reached the status of a committee

draft and includes e.g. test setups for measuring path repeatability of the turning width of a mobile robot. A third part dealing with manipulation performance is currently under preparation.

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/TR 60601-4-1 – Medical electrical equipment – Part 4.1: Guidance and interpretation – Medical electrical equipment and medical electrical systems employing a degree of autonomy (published)
 - IEC/CD 80601-2-77 – Medical Electrical Equipment – Part 2-77: Particular requirements for the basic safety and essential performance of medical robots for surgery (committee draft)
 - IEC/CD 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 (committee draft)

Other than industrial robots and (non-medical) personal care robots, robots used for healthcare purposes have to fulfil safety requirements for medical devices instead of or in addition to requirements for machinery safety. With this possible conflict in mind, a joint working group between ISO TC 299 (responsible for robot safety) and IEC SC 62 D (responsible for medical device safety) has been founded in 2010. The joint working group has spent some time on evaluating requirements for new standards on the safety of medical robots. As a first result, a technical report providing guidance on medical equipment with autonomous functions, ISO 60601-1-4, was published in 2016.

In 2015, two subgroups were 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. The second subgroup is dealing with medical robots used for rehabilitation and has recently started the development of IEC 80601-2-78.

Progress in WG 6 – Modularity

Chair: Gurvinder Virk (CLAWAR Association, United Kingdom)

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

Standard: ISO/AWI 22166-1 – Robotics – Part 1: Modularity for service robots – Part 1: General requirements

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. The goal of the standard is to provide guidance to manufacturers who want to develop their own modular architecture. Key sections being developed include

- Definitions

- Generic modularity issues (including connectivity, inter-operability and safety at the module level)
- Safety and security issues of modular systems
- Frameworks for hard- and software
- Key robotic components

During the last meeting in Budapest, the working group finished the processing of comments received in the new work item ballot. Based on the feedback it was decided to make some changes in the structure of the standard before the work on the content continues.

Progress in SG 1 – Gaps and structure

Chair: Gurvinder Virk (CLAWAR Association, United Kingdom)

Task: Identify gaps and overlaps between current working groups

When new robots are created, they are often not covered by existing standards. For example mobile robots with a manipulator for industrial workplaces are considered as industrial robots but are not directly covered by ISO 10218. Also in the area of service robots, domains like agriculture robots or mining robots are currently not covered by ISO 13482. This leads to gaps in the existing standardisation which need eventually to be filled. On the other hand, some overlaps safety standards and the scope of the respective working groups have been detected, e.g. on the boundary between medical and non-medical robots or the boundary between industrial robots and service robots.

To discuss these issues and to propose strategies to deal with them, the study group SG1 has been created in TC 299. The group will also seek contact to other standardisation committees which are currently dealing with questions regarding highly automated machines. The study group will report for the first time to the TC 299 plenary meeting in June 2018.

During its first meeting in Budapest, the study group collected work items that will be discussed in the coming year.

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 “Performance of household and similar electrical appliances”, various standards for vacuum cleaners have been developed in the past. In the last years, the committee has developed IEC 62849 which comprises performance evaluation methods for “mobile household robots”, robots that move in the household and perform intended tasks. The document has been published in 2016. The standard focuses on robots with the typical shape and abilities of a vacuum cleaning robot.

In TC 116 “Safety of motor-operated electric tools”, 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 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:

- October 10th to 15th, 2017: Subsequent meetings of WG 1, 2, 4 and 6 in Suzhou, China
- January 29th to February 8th, 2018: Subsequent meetings of WG 1, 2,3, 4 and 6 in Washington DC, USA
- May 28th to June 8th, 2018: Subsequent meetings of WG 1-6 in Kyoto, Japan

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.

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.²

In 2014, a topic group on standardisation was created³. 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 Gurvinder Virk who is also the chairman of the ISO working groups 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.

² Topic Groups: <http://www.eu-robotics.net/ppp/objectives-of-our-topic-groups/>

³ List of euRobotics Topic Groups (as of August 23th , 2015):
https://eu-robotics.net/cms/upload/List_of_Topic_Groups_without_contacts_August2015.pdf

Compiled and written by

Dipl.- Ing. Theo Jacobs

CMSE[®] - Certified Machinery Safety Expert

Project manager Household and Assistive Robots

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

Nobelstraße 12 | 70569 Stuttgart | Germany

Phone: +49 711 / 970 -1339 | Fax -1008

E-mail: theo.jacobs@ipa.fraunhofer.de

Website: <http://www.ipa.fraunhofer.de/en/human-robotinteraction.html>

Theo Jacobs is working as a research scientist at Fraunhofer IPA, focused on mechanical engineering in the field of mobile service robots for industrial and domestic use. He is a technical expert in the ISO standardisation committee TC 299 where he is engaged in the development of a safety standard for personal care robots. Besides his ISO work, he also involved in projects including safety trainings, feasibility studies, risk analyses and risk mitigation for mobile robots. In case of questions or comments, please feel free to contact him.

The RockEU 2 Coordination Action is funded by the European Commission within the H2020 Framework Programme (H2020- ICT-688441; 02/2016 – 01/2018)