Standardisation Efforts on Industrial and Service Robots

In the last years, the robot market has experienced a double-digit annual growth that will continue in the coming years. In the industrial sector, the introduction of collaborative workplaces where humans and robots work safely together is one of the great challenges these days. Meanwhile the service robot market experiences the introduction of new innovative robotic products and applications each year.

In order to bring a robotic product on the market, manufacturers have to fulfil safety regulations. Apart from existing general (type A and type B) safety standards, product specific (type C) safety standards are of significant value to manufacturers as they ease hazard analysis and also reduce the legal risk for research facilities and companies. To satisfy this demand, the international standardisation organisation (ISO) has been developing safety standards in the domain of industrial and service robots for many years.

While safety standards form the basis to establish a robotic product on the market, other standards can help to reduce trade barriers and to foster market growth. Standards on terminology and coordinate systems improve communication between manufacturers, suppliers and end users and are a first step towards exchangeable robot components. In a few years, more standards on robot modularity can be expected that will help to make robot systems reconfigurable and highly interchangeable. Further initiatives have started to create standards for benchmarking robot performance, making complex robots' abilities measurable with the goal to increase market transparency.

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

Robot-related standardisation at ISO

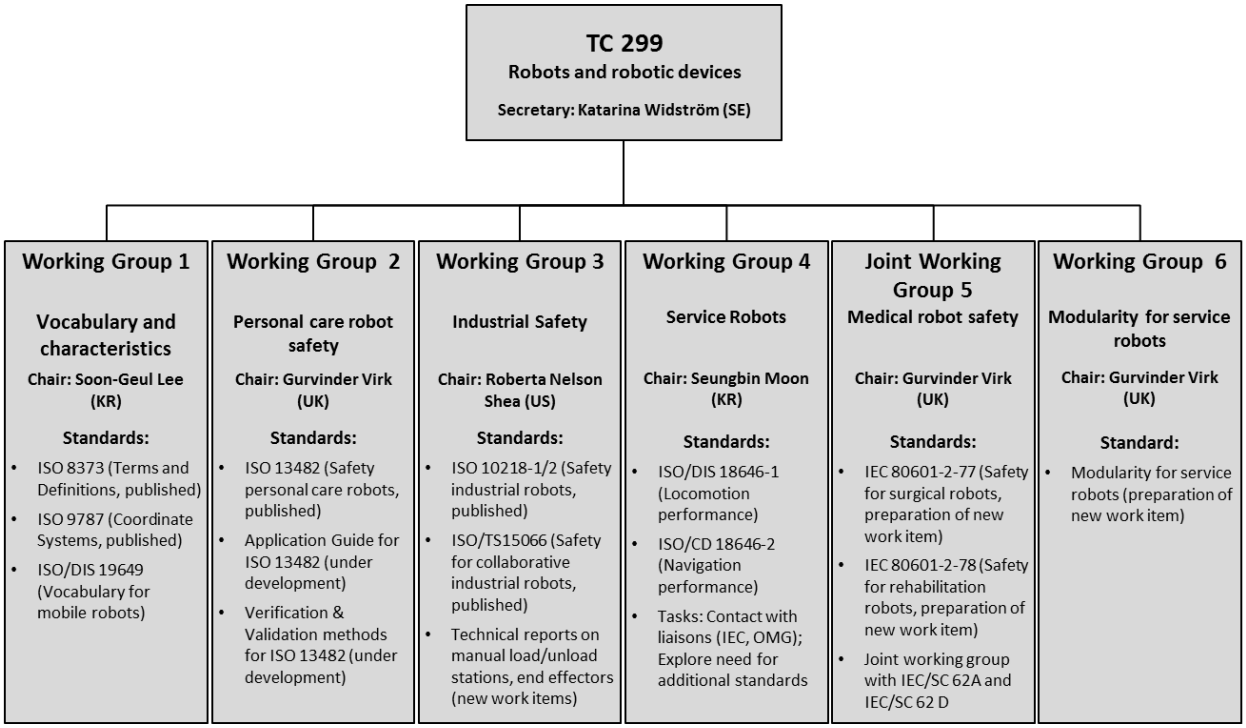

Fig. 1 Current structure of ISO TC 299

In the past, standardisation related to robots was covered in ISO technical committee TC 184 "Industrial Automation" in the subcommittee SC 2 "Robots and robotic devices". With the beginning of 2016, an important step has been done to underline the importance of robots by upgrading the former SC 2 to a technical committee of its own. The newly formed TC 299 "Robots and robotic devices" will in the future

The RockEU Coordination Action is funded by the European Commission within the 7th Framework Programme (FP7- ICT-2013.2.2; 01/2013 – 06/2016)

bundle all standardisation related to industrial and service robots. 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, the Netherlands, Japan, 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].

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

WG 1 has the task to compile and harmonize terminology and definitions used in standards for industrial and service robots. To complement the already published ISO 8373 which contains basic definitions for the domains of industrial and service robots, WG 1 is currently finalizing the new standard ISO 19649. This standard will provide an extended vocabulary for mobile robots. Examples are the exact definition of different kinds of turning manoeuvres and the measurement of "turning radius" for mobile robots. The standard has recently entered the DIS balloting which is the last balloting stage prior to publication in which changes of the technical content of the document may be requested.

During its last meeting in Nagoya, the working group also agreed on updated definitions of the terms "robot", "robotics" and "robotic technology" which will form the bases for the scope of the newly founded TC 299. In the future, WG 1 will probably also discuss the definition of "autonomy". A goal is to establish several degrees of autonomy which can be used to classify a robot.

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)
- Technical report: Application guide for ISO 13482 to be published as a technical report (new work item)
- Technical report: Validation criteria for personal care robots (new work item)

Due to the upgrade of the standardisation committee, the former WG 7 has now become WG 2. After the publication of ISO 13482 in 2014, the first safety standard for personal care robots, the working group has started working on two documents to further support this standard. In a technical report that is currently

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

[2] www.robotstandardisation.org

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under preparation, verification and validation measures are described which can be used by robot manufacturers for safety testing. Tests include for example stability tests for different travel patterns (e.g. on ramps or while accelerating or stopping), but also impact tests.

A second technical report that is developed by the group provides guidance on how to perform risk assessment and risk reduction for personal care robots. Currently, the group is discussing detailed examples for a risk assessment for different robot types which will be included in the document. In addition, WG 2 is exploring the need for formulating robot impact dummy specifications as well as how ISO 13482 should be developed in the future.

Progress in WG 3 – Industrial safety

Chair: Roberta Nelson Shea (Rockwell Automation, USA)
Standards:
- ISO 10218-1 – Robots for industrial environments – Safety requirements – Part 1: Robot (published in 2011)
- ISO 10218-2 – Robots for industrial environments – Safety requirements – Part 2: Industrial robot system 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. ISO/TS 15066 builds on the well-established safety standards ISO 10218-1 and -2 which are also maintained by this working group.

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.

Progress in WG 4 – Service robots

Chair: Seungbin Moon (Sejong University, South Korea)
Task: Determining need for additional standards for service robots
Standards:
- ISO/DIS 18646-1 – Robots and robotic devices – Performance criteria and related test methods for service robot – Part 1: Locomotion for wheeled robot (draft international standard)
- ISO/CD 18646-2 – Robots and robotic devices – Performance criteria and related test methods for service robot – Part 2: Navigation (working draft)

In the newly formed TC 299, the former WG 8 has changed its number to WG 4. The group is 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. Two years ago, WG 4 started the development of ISO 18646-1, a standard for measuring locomotion performance. The current draft is in the final balloting stage and will soon be published. A second part on navigation performance is currently under preparation and will include e.g. test setups for measuring path repeatability or the turning width of a mobile robot.

In addition, WG 4 has since many years the special task to monitor the development on the service robot market and the preparation of robot-related standards in other working groups. In the last years, several liaisons have been established with IEC, because the development of standards for autonomous vacuum cleaners and lawn-movers has been initiated there.

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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 (new work item)
- IEC 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 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 (the former JWG 9) is a Joint Working Group in cooperation with IEC/SC 62A and IEC/SC 62D. The working group has spent several years exploring the need and possible scope of robot-related standards for medical applications. As a result, the technical report IEC 60601-4-1 has been drafted. The work is providing guidance on including autonomy into medical equipment and the impacts it can add to basic safety and essential performance. The report is almost completed and its balloting is expected in July 2016.

JWG 5 identified two items for which further safety standards will be developed in the future and has initiated two subgroups to deal with these items. The first subgroup is focusing on medical robots for surgery and has recently started to develop a standard for basic safety and essential performance for such applications. The second subgroup will do the same for medical robots used for rehabilitation and compensation of diseases, injuries or disabilities.

Progress in WG 6 – Modularity for service robots

Chair: Gurvinder Virk (CLAWAR Association, United Kingdom)
Co-Chairs: Shuping Yang (RIAMB, China), Hongseong Park (Kangwon National University, South Korea)
Standard: Modularity for industrial and service robots (new work item)

Through the upgrade of the standardisation committee, the former WG 10 has now become WG 6. This working group has the task to prepare the development of a new standard for interoperability and reusability of robotic components on a mechanical, electrical and software level.

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

1. Definitions
2. Generic modularity issues (including connectivity, inter-operability and safety at the module level)
3. Hardware framework
4. Software framework
5. Key robot modules
6. Use cases

During the latest meeting in Nagoya in February 2016, it was agreed to try and aim the new work project to start at the end of 2016 and so the modularity standard for service robots can be expected to be published in 2020.

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!

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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:

- June 27th to July 7th 2016: Subsequent meetings of WG 1, 2, 4, 5 and 6 in Oxford, United Kingdom
- June 13th – 16th 2016: Meeting of WG 3 in Gothenburg, Sweden
- November 7th to 18th 2016: Subsequent meetings of WG 1-6 and TC 299 plenary in Orlando, Florida, Unites States

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 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

With 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 the member of euRobotics AISBL or not), but, first and foremost, to prepare the roadmap and project calls that precede such proposals.[3]

In 2014, a topic group on standardisation was created which deals with standardisation activities in ISO, IEC and other standardisation organisations. A focus lies on research activities to support standardisation, e.g. to provide experimental data which can be included in standards or can be used to validate the requirements in standards. The standardisation topic group is headed by Gurvinder Virk and Paolo Barattini.[4]

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

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

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Standardisation Newsletter

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