ICRES 2022: 7th International Conference on Robot
Ethics and Standards, Seoul, South Korea, 18-19 July 2022.
https://doi.org/10.13180/icres.2022.18-19.07.025

VOCABULARY STANDARD FOR ROBOTICS IN ISO

SOON-GEUL LEE

Department of Mechanical Eng. and Integrated Education Institute for Frontier Science and Technology (BK21 Four), Kyung Hee University, 1732 Deogyeongdae-ro. Giheung-gu Yongin, Gyeonggi-do, 17104, Korea

E-mail: sglee@khu.ac.kr
www.khu.ac.kr

ISO 8373 specifies vocabulary of terms and the related definitions used in ISO documents for robotics. It defines fundamental and common vocabulary in ISO TC 299 (Robotics). The last revision on vocabulary was published in 2012, and it focused mainly to enhance the existing standard and to expand to cover the terminologies for service robots on industrial robots. ISO TC 299/WG 1 (vocabulary and characteristics) was formed to revise this standard. The final version has been developed by experts and published in 2021. Revisions are summarized in this paper.

1. Introduction

As the application area where intelligent robots are utilized expands and the global robot market is rapidly emerging in recent years, standard development organizations (SDOs), such as ISO (International Organization for Standardization), IEC (International Electrotechnical Committee), IEEE (Institute of Electrical and Electronics Engineers), OMG (Object Management Group), and ASTM (American Society for Testing and Materials), are trying to lead the standardization of the robotics field [1]. These SDOs are in a very challenging position to regulate rising domains which evolve much faster than the traditional creation cycle of a technical standard.

ISO and IEC are two major SDOs with international credibility. While ISO is developing standard for robotic area through the technical committee TC 299 (robotics) by centralized manner, IEC's robot standardization works in a distributed structure. IEC develops standards for individual robotic product by the respective TCs and SCs (subcommittees) for different application areas, such as lawn mowers, vacuum cleaning robots, or other type of household appliances. However, IEC created an Advisory Committee on Applications of Robotics Technology (ACART) to coordinate robot standardization activities within ISO and IEC.

OMG has launched the Robotics DTF (Domain Task Force) in 2005, and is currently the most active in international standardization for robot software, such as robotic middleware and its architecture. IEEE develops reports on standards by the IEEE Robotics and Automation Society (RAS). IEEE RAS has been active in standardization for more structural standards based on ontologies. ASTM has established committee E54.08(Operational Equipment) to develop standards on urban search and rescue robots. It has published standards on urban search and rescue robots, including vocabulary and performances.

The largest number of robot-related standards has so far been developed by the ISO. Originally, ISO TC184 (Industrial automation systems and integration) / SC2 which handled standards in the field of industrial robots was decided to include service robots while expanding the scope from "Robots for Industrial Environments" to "Robots and Robotic Devices" in 2006 [2]. Now, ISO TC 299 (Robotics) was newly formed by upgrading ISO TC184/SC2. It takes charge of all ISO standardization activities related to robotics, including diverse liaisons with IEC on medical robotics [3].

ISO 8373(Vocabulary) was first published in 1994 and contained mainly terms for industrial robots. The second edition was expanded to include both industrial robots and service robots and published in 2012 [4]. The last revision was published in 2021 to resolve mismatching and harmonization between different robot groups. In this paper, key vocabularies introduced in the current revision are described.

2. Basic vocabularies

The terms defined in ISO 8373 and their definitions are not only applied to other ISO standards and standards of other SDOs, but are also accepted as fundamental terms by the industry and research community in the field of robotics [5]. for example, IFR (International Federation of Robotics) uses the definitions contained in ISO 8373 "Vocabulary" when compiling statistics of industrial robots in particular countries.

As is commonly known, the vocabulary standard is essential because it must clarify the meaning of terms used in the development of a set of standards such as interfaces, performance measures and safety requirements. In the new revision, according to the emergence of new types of robots and industries, some terms and definitions that conflicts with the existing definitions were resolved by coordinating among robot groups.

The old definition of robot was described based on the mechanism point of view of an industrial robot. The definition of robot is revised to hold more broad meaning so that it can commonly be applied to service robots, but it might include some mechanisms which may not be considered as robot. To alleviate these concerns, it is specified that robots must have degree of autonomy. It was concluded that additional definitions or supplements for degree of autonomy should be defined as additional standards.

Because the revised robot definition reflects the common nature of both industrial and service robots, each group under TC 299 is able to build definitions of sub-fields based on this robot definition [6].

The term of "robotic technology" is newly introduced because it supports detail domain and reasoning of TC name "robotics". The term of "robotic device" to designate the mechanisms which might not be defined as robots according to the strict definitions of industrial robots or service robots, but utilized essential robotic technologies.

robot

programmed actuated mechanism with a degree of autonomy to perform locomotion, manipulation or positioning

NOTE 1 to entry: A robot includes the control system and interface of the control system.

NOTE 2 to entry: Examples of mechanical structure of robots are manipulator, mobile platform and wearable robots.

autonomy

ability to perform intended tasks based on current state and sensing, without human intervention

NOTE 1 to entry: For a particular application, degree of autonomy can be evaluated according to the quality of decision making and independence from human. For example, metrics for degree of autonomy exists for medical electrical equipment in IEC/TR 60601-4-1.

robotic technology

practical application knowledge commonly used in the design of robots or their control systems, especially to raise their degree of autonomy

Examples: perception, reasoning and planning algorithms

robotic device

mechanism developed with robotic technology, but not fulfilling all characteristics of robot

EXAMPLES Teleoperated remote manipulator; haptic devices, end-effector, unpowered exoskeletons, etc.

The definitions of industrial robot and service robot were revised as below, and the definitions of medical robot was newly defined based on the revised definition of robot. This means that robot is currently classified into industrial robot, service robot or medical robot, and the classification is done by its application not by its mechanical structures. This means that the robot classification can be newly classified according to the emergence of new types of robots according to the market in the future.

industrial robot

automatically controlled, reprogrammable multipurpose manipulator(s), programmable in three or more axes, which can be either fixed in place or fixed to a mobile platform for use in automation applications in an industrial environment

NOTE 1 to entry: The industrial robot includes:

— the manipulator, including robot actuators controlled by the robot controller;

— the robot control;

— the means by which to teach and/or program the robot, including any communications interface (hardware and software).

NOTE 2 to entry: Industrial robot includes any auxiliary axes that are integrated into the kinematic solution.

NOTE 3 to entry: Industrial robots include the manipulating portion(s) of mobile robots, where a mobile robot consists of a mobile platform with an integrated manipulator or robot.

service robot

robot in personal use or professional use that performs useful tasks for humans or equipment

NOTE 1 to entry: Tasks in personal use include handling/serving of items, transportation, physical support, providing guidance/information, grooming, cooking and food handling, and cleaning.

NOTE 2 to entry: Tasks in professional use include inspection, surveillance, handling of items, person transportation, providing guidance/information, cooking and food handling, and cleaning.

medical robot

robot intended to be used as medical electrical equipment or medical electrical systems

NOTE 1 to entry: A medical robot is not regarded as an industrial robot or a service robot ;.

robotics

science and practice of designing, manufacturing, and applying robots

3. Additional vocabularies

Terms such as "collaboration" and "cooperation" were revised to enhance their definition so that it can be used in precise context in other standard documents. "Collaboration" designates the situation where human and robot work together and "cooperation" is used for multiple robot cooperation. This distinction is essential in safety requirement documents, since the safety nature in "collaboration" mode is very critical.

Because "mobile platform" is more likely to be confused with other types of mobile devices, the note 3 to entry described its difference from automated guided vehicle (AGV). The note 2 to entry was added for the case that a mobile manipulator would appear as a emerging robot type in a near future.

Now the market of "wearable robot" is growing rapidly in industry and in military sides. According to these circumstances, the definition of "wearable robot" was carefully defined because it can be controversial from the point of view of "degree of autonomy".

collaboration

operation by purposely designed robots and person working within the same space

robot cooperation

information and action exchanges between multiple robots to ensure that their motions work effectively together to accomplish the task

human–robot interaction

HRI

information and action exchanges between human and robot to perform a task by means of a user interface

EXAMPLES Exchanges through vocal, visual and tactile means.

NOTE 1 to entry: Because of possible confusion, it is advisable not to use the acronym "HRI" for human–robot interface when describing user interface.

mobile platform

assembly of the components which enables locomotion

NOTE 1 to entry: A mobile platform can include a chassis which can be used to support a load.

NOTE 2 to entry: A mobile platform can provide the structure by which to affix a manipulator.

NOTE 3 to entry: Mobile platform following a predetermined path (5.5.4) indicated by markers or external guidance commands, typically used for logistic tasks in industrial automation is also referred to as Automated Guided Vehicle (AGV) or Driverless Industrial Truck. Standards for such vehicles are developed by ISO/TC110.

wearable robot

robot that is attached to and carried by the human during use and provides an assistive force for supplementation or augmentation of personal capabilities

As the performance and safety standards of service robots were discussed, there was a discussion of definitions related to spaces which are used differently from industrial robots. A typical example is the case of "maximum space". There was an opinion to discuss and revise this at once in connection with the "restricted space" discussed in the industrial robot group, but it was decided as in the other basic definitions as follows.

maximum space

space which can be swept by the moving parts of the robot, plus the space which can be swept by the end-effector and the workpiece

NOTE1 to entry: maximum space of the robot system can include the space which can be swept by the end-effector and the workpiece

NOTE1 to entry: For mobile platforms, this volume can be regarded as the full volume that can theoretically be reached by travelling.

working space

space which can be swept by the wrist reference point

NOTE 1 to entry: The working space is smaller than the space which can be swept by all the moving parts of the manipulator.

safeguarded space

space where safeguards are active

NOTE 1 to entry: This is sometimes described as the space within the perimeter safeguarding

NOTE 2 to entry: The safeguarded space can change dynamically.

navigation

process which includes path planning, localization, mapping, and providing the direction of travel

NOTE 1 to entry: Navigation can include path (5.5.4) planning for pose-to-pose travel and complete area coverage.

Key terms used in the modularity group were newly defined. “Component” is not a physical part used in general machines and electronics, but a conceptual element commonly applied to software and hardware. Components are able to connect, interact, or exchange resources (such as energy or data) in some way, by adhering to a standardized interface. “Module” is an independent sub-unit for a body based on “component” concept. The term “modularity” is widely used in studies of technological and organizational systems. Robots are deemed "modular", for example, when they can be decomposed into a number of components that may be mixed and matched in a variety of configurations.

component

part of something that is discrete and identifiable with respect to combining with other parts to produce something larger

Note 1 to entry: Component can be either software or hardware. A component that is mainly software or hardware can be referred to as a software or a hardware component respectively.

Note 2 to entry: Component does not need to have any special properties regarding modularity.

Note 3 to entry: A module is a component, whereas a component does not need to be a module.

modularity

set of characteristics which allow systems to be separated into discrete modules and recombined

module

component or assembly of components with defined interfaces accompanied with property profiles to facilitate system design, integration, interoperability, and re-use

Note 1 to entry: A module may have both hardware and software aspects. It may consist of other components (hardware and software) or other modules (hardware and software).

Note 2 to entry: This neither requires nor prevents the use of Open Source Software to implement parts or all of the open module’s functionalities.

4. Conclusion

The recent revision of ISO 8373:2021 at TC 299/WG 1(Vocabulary and characteristics) was summarized. Experts from USA, UK, Germany, France, Sweden, Japan, and Korea has been actively engaged in the WG 1 activity during last few years. As the robot industry is widened to include both industrial robot and service robot, we needed to expand the vocabulary standard to harmonize the terminology used in both areas. We wish that the use of ISO 8373 will facilitate the development of robotic products in the market.

Acknowledgments

It was supported by Ministry of Trade, Industry and Energy under Robot Industrial Core Technology Development Project program (K_G012000921401 and 20015052) supervised by the KEIT.

References

1. S. Moon, S. Rhim, Y.-J. Cho, G. S. Virk, "International standardization activities in robotic fields", in Proc. 12th Int. workshop on Climbing and Walking Robots and Support Technologies for Mobile Machines, pp. 140-146, 2009.
2. S. Moon and G. S. Virk, "Survey on ISO standards for industrial and service robots", in Proc. ICROS-SICE Int. Joint Conf., pp. 1878-1881, 2009.
3. C. Harper, S. Dogramadzi, and M. O. Tokhi, "Development in vocabulary standardization for robots and robotic devices", in Proc. 12th Int. Conf. on Climbing and Walking Robots and Support Technologies for Mobile Machines, pp. 155-162, 2009.
4. ISO Standard, ISO 8373:2012(E) Robots and robotic devices — Vocabulary.
5. S. Moon, S.-G. Lee and K.-H. Park, "Recent progress of robotic vocabulary standardization efforts in ISO," in Proc. SICE Annual Conf., pp. 266-268, Aug. 2010.
6. S. Moon, S-G. Lee, "Revision of Vocabulary Standard for Robots and Robotic Devices in ISO", Proc. 15th Int. Conf. on Climbing and Walking Robots and the Support Technologies for Mobile Machines, Baltimore, MD, USA, 23-26 July 2012