Human-Robot Interaction in Service and Industrial Contexts: Similarities and Differences

AKLI Isma
Division Productique et Robotique(DPR)
Center for Development of Advanced Technologies (CDTA)
Algiers, Algeria
https://orcid.org/0000-0002-2332-0213

YACEF Fouad
Division Productique et Robotique (DPR)
Center for Development of Advanced Technologies (CDTA)
Algiers, Algeria

CHAABANI Abderahmane
Departement d'Informatique
Université des sciences et de la technologie Houari-Boumédiène
Algiers, Algeria

DAGHEFALI Asma
Departement d'Informatique
Université des sciences et de la technologie Houari-Boumédiène
Algiers, Algeria

***Abstract*—Robots are nowadays able to interact with humans in service or industrial domains applications. The robots can serve humans, or execute tasks conjointly with them, depending on tasks requirements and on robot capabilities and characteristics. That depends also on the sensorial system. Human Robot Interaction (HRI) for industrial or service robotics have many similarities, and differences. We propose in this article to enumerate some specificities to distinguish industrial robotics from service robotics in HRI context.**

***Index Terms*—Human Robot Interaction, Service, Industrial.**

I. Introduction

Robots increasingly interact with humans, as needed for new application domains. Human Robot Interaction (HRI) is defined, based on the extremely precise definition of the International Organization for Standardization (ISO8373:2021) as "information and action exchanges between human and robot to perform a task by means of a user interface" [1] [2]. Indeed, HRI aims to establish a communication between robots and humans. According to the definition, HRI is based on the exchange of information based on a kind of "agreement" between the robot(s) and the human(s), even if the decisional level of the human and the robot are not the same. The human and robot have respectively intuitive and adaptive roles [3]. The communication can be verbal, or non verbal to exchange information, and/or in form of action, in order to execute a task. A user interface is required (microphone, graphic user interface…). Two general categories of communication can be considered in HRI, the remote interaction, where the human and the robot are separated spatially (and temporarily), and the proximate interaction, where the humans and the robots share the same space [4]. The interaction can be physical (pHRI), covering proximal and remote (bilateral teleoperation) interaction [5] or cognitive (cHRI) allowing understanding of human expectations by the robot, in order to propose a cognitive responses. [6] In this article, we propose to define and study the functionality of industrial and service robots, in order to have a global overview about the two application domains, in the aim to perceive similarities and differences, and to apprehend better issues common to the two application domains. We propose in this paper to enumerate the different specificities of Human robot roles during the interaction, in industrial and services robotics. Robots perceive humans as entities not predictable, since the human also particularly if he is not accustomed to have robot around him.

Section 2 is dedicated to defining the industrial robots in the context of human robot interaction and Section 3 is dedicate to the discussion.

II. Human Robot Interaction for industry and Service

A. Industrial Robotics

1) Definition: Industrial robot is an "automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications."(ISO 8373:2021) [1]. Regarding to this definition mobile robots are excluded, not considered as industrial robots, since the executed task is accomplished in a factory.

2) Brief History: Industrial robots were initially completely separated to human workers [7] [2], dedicated to accomplish simple tasks, due to the absence of external sensorial systems. Humans workers have been, mainly, replaced by robots, for performing repetitive and tedious tasks [8]. In the beginning, industrial robots were, hydraulically powered, large and powerful, very efficient but not disposed to have humans working around. The technology being developed, electric drive robots with servo controls appeared, expanding the use of industrial robotics in factories. At that time security was limited to isolating the human from the robot [3], Then, Human robot interaction emerged based on communication techniques. The coexistence of humans and robots in industrial context was explored for certain tasks (maintenance, increase welding versatility. . .) [7] [3], then extended to more complex tasks. The human robot cooperation was the next reached step, followed by Human robot collaboration [3]. The human being able to be in the same workspaces as industrial robots, the risks augment. It was important to create safety standards allowing humans to work with robots in more secured industrial environments [7]. Regarding to industrial application domain, the humans and the robots can Coexiste (HRCx), Cooperate (HRCp) or Collaborate (HRC) with different modalities as Physical collaboration and Contactless collaboration [9]. The degrees of interaction can be thus Independent, Simultaneous, Sequential, or Supportive [10]. The roles of the robots and the humans can be inactive, supportive or active. In the context of HRC, the human and robot adjust dynamically their respective roles [3].

Many distinguished classes are cited in literature [2] [17] as:

- “Handling operations/machine tending”,
- “Welding and soldering (all materials)”,
- “Dispensing”,
- “Processing”,
- “Assembling and disassembling”.
- ”Painting”
- ”pick and place” for printed circuit boards,
- ”packaging”,
- ”labeling”,
- ”palletizing”,
- ”product inspection”,
- ”testing”,

Industrial robots perform with high endurance, speed, and precision in all of those tasks. The integration of the humans in the environment of industrial robots requires the decrease of motion speed of the robots and an efficient exteroceptive sensorial system allowing detecting human position.

The information exchanged between humans and robots via user interfaces, for industrial robots can be direct, passing throw speech, gesture, etc, or indirect with gesture recognition, facial expression etc, [12] [9].

In the context of industrial robots, the co-workers should be highly qualified with a technical understanding. [8]

Robots were from the 1960s to the ’90s, dedicated to accomplish industrial tasks. Nowadays, robots became ubiquitous, able to communicate with humans and serve them [13].

B. Service Robotics

1) Definition: Service robot is “robot in personal use or professional use that performs useful tasks for humans or equipment” [1].

2) tasks: The type of tasks to be performed by service robots is also defined regarding to the standard ISO 8373:2021 subdivided in two classes : “Tasks in personal use include handling or serving of items, transportation, physical support, providing guidance or information, grooming, cooking and food handling, and cleaning”. “Tasks in professional use include inspection, surveillance, handling of items, person transportation, providing guidance or information, cooking and food handling, and cleaning“

In reality there are huge number of domains where service robots can operate [14]:

a) Professional Service Robots:

- Defence Robots,
- Field Robots,
- Robots in medical settings,
- Logistic Robotic Systems,
- Maintenance Robots.

b) Personal Service Robots:

- Social Robots,
- Domestic Cleaner Robots,
- Research/Educational/Competition Robots,
- Assistance Robots,
- Therapeutic Robots.

Historically , it is difficult to define when the service robots appear, Machines helping or entertaining the human can be treated as its precursors. [15], however, some service robots were developed for the jobs where a task execution by human is dangerous, impossible or unacceptable. Those robots are mobile platforms, manipulators, tele-manipulators or mobile robots with manipulation abilities.

The first service robots as describes nowadays, developed in research laboratories, were dedicated to mobile robot navigation and for space or volcano exploration. Indeed, the evolution of service robots depend on the progress of sensing technologies, control equipment, with actuators and power supplies. The service robots can have different forms and heights, however, most of them are mobile and autonomous [14]. The human environment is in general shared with service robots. The robot should have enough intelligence to communicate naturally with human and understand the orders to accomplish the assigned tasks. [13]. The development of aspects related to human robot interaction for service robotics is motivated with the safety standards issued by the International Organization for Standardization (ISO). The robots and humans can be in contact and share the same workspaces [15].

Several modalities of communication can be performed for service robots as gesture based interfaces, Natural language Interfaces, etc. The modalities of communication can be unimodal(one communication mode e.g. speech, or gesture) or multimodal (many communication modes e.g. gesture with facial expression in the same time) [12]

III. Discussion

The difference between robotic in the context of service or industrial can be viewed in several angles : In term of interface [14], in terms of communication modes, in terms of tasks to be performed, in terms of human and robot roles, in terms of robot types, many robots are mobile in the context of service robotics, compared to industrial robotics. We propose in this discussion to enumerate the differences and the similarities

A. Some Similarities

- In the relationship between the robots and the human, each of the two entities can take three kinds of roles (in industrial contexts) interactive, supportive or active roles. This is easily retranscriptable for service robotics [3]
- The information exchanged between humans and robots can be direct, passing throw speech, gesture, etc, or indirect with gesture recognition, facial expression etc, for industrial and service robots [12] [9].
- The development of aspects related to human robot interaction for service and industry is motivated with the safety standards issued by the International Organization for Standardization (ISO). The robots and humans can be in contact and share the same workspaces [15].
- Cognitive interaction methods stays the same with the same sensorial systems , as some tasks (maintenance, logistics, ...). Some types of robots stay the same for the two domains like MiR mobile robots and "KMR iiwa" [16]
- In industrial robots, the human robot teams exist, however, in service robotics, some application domains as robotics of security and safety can be also call for humans robot teams for search and rescue robotics. The same approaches can be performed.
- Collaborative robots can be used for service and industrial robotics
- The communication modes for exchanging information between robots and humans are the same in industrial .and service robotics, with the same modalities with direct and indirect communication modes.

B. Some Differences

- The human robot interaction is explicitly cited in the (ISO8373:2021)definition bibitemb1, compared to industrial robots. In service robotics, the type of service robots as well as their role in the society for humans is obvious (well expressed in the definition bibitemb1). In the definition of the industrial robots, the kinematic form of the robot appears to be more important.
- There are safety standards related to both industrial and service robotics, however, in the two contexts, the standards are different. The safety requirements for personal care robots standard [17] are different from the safety requirements for industrial robots standards [18].
- In industrial robotics, since the users are in general experts, there are accustomed to be in contact with classically shaped robots. Instead of service robotics, where the shape of the robots is important, particularity for robots communicating with children, for social applications.
- Service robotics consist on offering service to humans by robots, unlike to industrial robotics where human is called by the robot if a problem occurred, for learning, or maintenance etc.

IV. Conclusion

The presented study in this article shows the different particularities of service and industrial robotics in relation with HRI systems. Indeed, HRI became an important topic since the robot became more autonomous, and the Artificial Intelligence algorithms became widely used. Its is interesting to extend the proposed work with strengthen the study presented in this article with other parameters.

References

[1] ISO 8373:2021, Robotic—Vocabulary, 2021. http://www.iso.org.

[2] R. Klump, A. Jurkat, Anne, F. Schneider, "Tracking the rise of robots: A survey of the IFR database and its applications". MPRA Munich Personal RePEc Archive, 2021

[3] S. Li, R. Wang, P. Zheng, and L. Wang, "Towards proactive human–robot collaboration: A foreseeable cognitive manufacturing paradigm". Journal of Manufacturing Systems, Vol 60, pp. 547-552, 2021

[4] M. A. Goodrich and A. C. Schultz. "Human-robot interaction: A survey". Found. Trends Hum.-Comput. Interact., Vol 1, n° 3, pp. 203–275, 2007.

[5] M. Selvaggio, M. Cognetti, S. Nikolaidis, S. Ivaldi, and B. Siciliano, "Autonomy in physical human-robot interaction: A brief survey". IEEE Robotics and Automation Letters.2021

[6] B. Mutlu, N. Roy, S. Šabanović, "Cognitive Human–Robot Interaction". Springer Handbook of Robotics. Springer Handbooks. Springer, Cham. 2016

[7] J. Fryman, and B. Matthias, "Safety of industrial robots: From conventional to collaborative applications". ROBOTIK 2012; 7th German Conference on Robotics, pp. 1-5, May 2012.

[8] J. Wallén, "The history of the industrial robot". Linköping University Electronic Press, 2008.

[9] A. Hentout, M. Aouache, A. Maoudj and I. Akli, "Human–robot interaction in industrial collaborative robotics: a literature review of the decade 2008–2017", Advanced Robotics, Taylor and Francis, Vol 33, n°15-16, pp. 764-799, 2019.

[10] Z. Dobra, KS. Dhir. "Technology jump in the industry: human–robot cooperation in production". Industrial Robot: the international journal of robotics research and application. 2020

[11] A. Olivares-Alarcos, D. Beler, A. Khamis,P. Goncalves, M. K. Habib, J. Bermejo-Alonso, M. Barreto, M. Diab, J. Rosell, J. Quintas, J. Olszewska, H. Nakawala11, E. Pignaton, A. Gyrard1, S. Borgo, G. Alenya1, M. Beetz,H. Li, "A Review and Comparison of Ontology-based Approaches to Robot Autonomy", The Knowledge Engineering Review, 34, 2019.

[12] J. Berg, and S. Lu, "Review of interfaces for industrial human-robot interaction". Current Robotics Reports, 1(2), pp. 27-34, 2020.

[13] T. Haidegger, M. Barreto, P. Gonçalves, M.K. Habib, S.K.V. Ragavan, H. Li, and E. Prestes, "Applied ontologies and standards for service robots". Robotics and Autonomous Systems, Vol 61, n° 11, pp. 12151223, 2013.

[14] J.M, Garcia-Haro, E.D, Oña, J. Hernandez-Vicen, S. Martinez, and C. Balaguer, "Service robots in catering applications: A review and future challenges". Electronics, vol 10, n °1, p.47, 2020

[15] T. Zielinska, "Professional and personal service robots". International Journal of Robotics Applications and Technologies (IJRAT), Vol 4, n° 1, pp. 63-82, 2016

[16] I.Karabegovi, E.Karabegovi, M.Mahmi, E.Husak , and P.Daši, "The Implementation of Industry 4.0 Supported by Service Robots in Production Processes", 2021.

[17] ISO 13482:2014, Robots and robotic devices — Safety requirements for personal care robots, 2014. http://www.iso.org.

[18] ISO 10218-1:2011, Robots and robotic devices — Safety requirements for industrial robots — Part1: Robots, 2011. http://www.iso.org.