1.2 Classification of service robots by application areas

1.2.1 Definition "Service Robotics"

In a joint effort started in 1995, the United Nations Economic Commission for Europe (UNECE) and IFR engaged in working out a first service robot definition and classification scheme which has been absorbed by the current ISO Technical Committee 184 / Subcommittee 2 (see chapter 1.2.1) resulting in a novel ISO-Standard 8373 which had become effective in 2012. This International Standard specifies vocabulary used in relation with robots and robotic devices operating in both industrial and non-industrial environments. It provides definitions and explanations of the most commonly used terms, which are grouped into clauses by main topics of robotics. Its vocabulary definitions relate to industrial as well as to service robotics. Relevant robotics related definitions are:[4]

- A **robot** is an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks. Autonomy in this context means the ability to perform intended tasks based on current state and sensing, without human intervention.
- A **service robot** is a →robot that performs useful tasks for humans or equipment excluding industrial automation application. Note: The classification of a robot into industrial robot or service robot is done according to its intended application.
- A **personal service robot** or a service robot for personal use is a →service robot used for a non-commercial task, usually by lay persons. Examples are domestic servant robot, automated wheelchair, and personal mobility assist robot.
- A **professional service robot** or a service robot for professional use is a →service robot used for a commercial task, usually operated by a properly trained →operator. Examples are cleaning robot for public places, delivery robot in offices or hospitals, fire-fighting robot, rehabilitation robot and surgery robot in hospitals. In this context, an operator is a person designated to start, monitor and stop the intended operation of a →robot or a →robot system.
- A **robot system** is a system comprising →robot(s), end-effector(s) and any machinery, equipment, devices, or sensors supporting the robot performing its task.

Please note: According to the definition, "a degree of autonomy" is required for service robots ranging from partial autonomy (including human-robot interaction) to full autonomy (without operational human-robot intervention). Therefore, in addition to fully autonomous systems, service robot statistics include systems which may also be based on some degree of human-robot interaction (physical or informational) or even full tele-operation. In this context, human-robot interaction means information and action exchanges between human and robot to perform a task by means of a user interface.

1.2.2 Classification of service robots by application areas

Since the mid-90s, UNECE and IFR have adopted a preliminary definition and system

[4] ISO 8373:2012 Robots and robotic devices - Vocabulary; http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=55890.

for classifying service robots by categories and types of interaction which has converged over the years into the current classification scheme.

Since very few national organizations have had any comprehensive statistics on service robots at all, UNECE and IFR decided to collect statistics directly from the manufacturers of service robots worldwide. This process has been maintained (and improved) ever since with the only difference of transferring all statistics related activities to the IFR Statistical Department (located in Frankfurt/Main, Germany) since the year 2005. In regular, systematic mailings, service robot manufacturers are asked to report data broken down by application areas as shown in Table 1.1 and Table 1.2.

The IFR database is used to ask service robot manufacturers worldwide to send back information on robot sales (in units and value) from the previous year in each category and to estimate cumulated sales forecast for the coming 4 years, see Figure 1.1.

The process is typically conducted in the first half of the year, i.e. from February to June 2016. Response rate exceed 30%. Information which could not be retrieved from manufacturers directly is collected through data base research and other channels e.g. annual reports, market surveys and estimates.

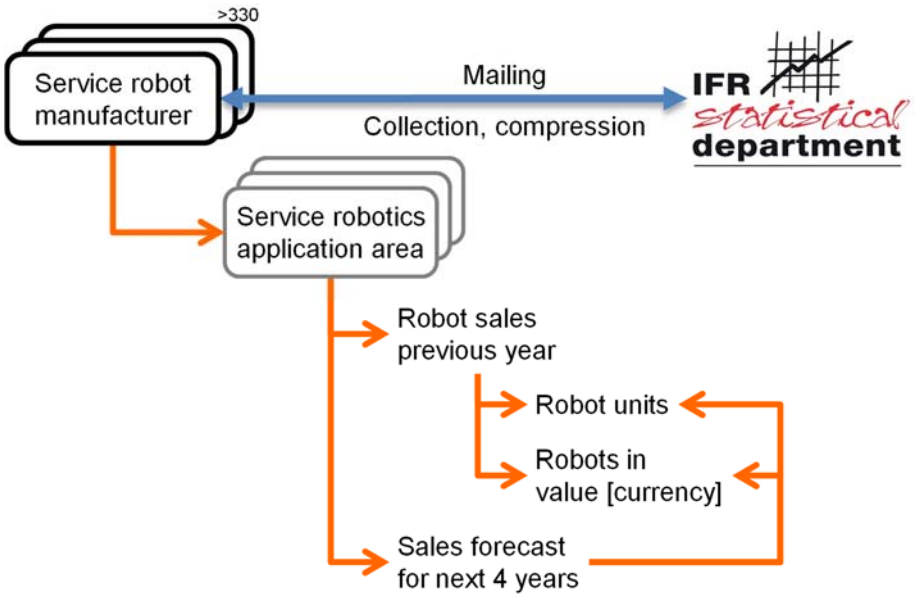

Figure 1.1: Simplified procedure of robot statistics data collection

Section I	Types of robots: Service robots for personal/domestic use
1-6	Robots for domestic tasks
1	Robot companions/assistants/humanoids
2	Vacuuming, floor cleaning
3	Lawn-mowing
4	Pool cleaning
5	Window cleaning
6	Others
7-10	Entertainment robots
7	Toy/hobby robots
8	Multimedia/remote presence
9	Education and research
10	Others
11-13	Elderly and handicap assistance
11	Robotized wheelchairs
12	Personal aids and assistive devices
13	Other assistance functions
14	Personal transportation (AGV for persons)
15	Home security & surveillance
16	Other Personal / domestic robots

Table 1.1: Classification of service robots by application areas and types of robots; service robots for **personal/domestic use**.

Section II	Types of robots: Service robots for professional use
17-23	Field robotics
17	Agriculture
18	Milking robots
19	Other robots for livestock farming
20	Forestry and silviculture
21	Mining robots
22	Space robots
23	Other field robotics
24-28	Professional cleaning
24	Floor cleaning
25	Window and wall cleaning (incl. wall climbing robots)
26	Tank, tube and pipe cleaning
27	Hull cleaning (aircraft vehicles etc.)
28	Other cleaning tasks
29-31	Inspection and maintenance systems
29	Facilities, plants
30	Tank, tubes, pipes and sewers
31	Other inspection and maintenance systems
32-35	Construction and demolition
32	Nuclear demolition & dismantling
33	Building construction
34	Robots for heavy/civil construction
35	Other construction and demolition systems
36-39	Logistic systems
36	Automated guided (AGV) vehicles manufacturing environments
37	AGVs non-manufacturing environments (indoor)
38	Cargo handling, outdoor logistics
39	Other logistic systems
40-43	Medical robotics
40	Diagnostic systems
41	Robot assisted surgery or therapy
42	Rehabilitation systems
43	Other medical robots
44-46	Rescue & security applications
44	Fire and disaster fighting robots
45	Surveillance / security robots
46	Other rescue and security robots
47-50	Defense applications
47	Demining robots
48	Unmanned aerial vehicles
49	Unmanned ground based vehicles
50	Unmanned underwater vehicles
51	Other defense applications
52	Underwater systems (civil / general use)
53	Powered Human Exoskeletons
54	Unmanned aerial vehicles (general use)
55	Mobile Platforms in general use
56-60	Underwater systems (civil / general use)
56	Hotel & restaurant robots
57	Mobile guidance, information robots
58	Robots in marketing
59	Robot joy rides
60	Others (i.e. library robots)
61	Other professional service robots not specified above

Table 1.2: Classification of service robots by application areas and types of robots.