A New Methodological Approach to Analyze Human Roles in Human-Robot Interaction Scenarios

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***Abstract*— The influence of robotics in the job market has socio-economic consequences and the inevitable loss of job positions, but in the Human-Robot Interaction (HRI) scenarios, where humans and robots work together, new jobs and business models will be created. These HRI scenarios can be seen in manufacturing, medicine, maintenance, education, etc. and in the future, in most of the daily tasks. The purpose of this article is to analyze from the perspective of Human-Robot Interaction scenarios, which new HRI human roles and HRI tasks categories has to be taken into account. The new HRI human roles will serve to define and homogenize the transverse skills needed for workers working in HRI scenarios and for analyzing the human roles in robotic experiments. We introduce a methodological approach using the TERRINet HRI Template, which facilitates the analysis of tasks that in the near future will be done by humans working with robots. The Template has been used and tested in 20 study cases of HRI scenarios, validating the methodology and looking for homogenization in human roles.**

I. Introduction

Robotic technology will be part of our the economic activity, improving the tasks that humans perform now and increasing the quality of human life and work. Robots are here to help and collaborate with humans creating a new system that will link the best of both. In this article we will refer to Human-Robot Interaction (HRI) scenarios, where humans and robots work together, although there could be a balance between full autonomy and pure tele-operation.

The human robot interaction literature points the consequences of the introduction of robotic technologies in the labor market and the consequences for human roles, which will lose part of the interesting tasks that they perform, for example, contact with customers [1], social acceptance or work comfort [2]. The reason could be that the employees often do not have the right skills to learn new technologies and fail to understand the benefits of robotics, leading to confusion, resistance and decreasing trust on robots [3]. In the other hand, some literature defends that the introduction of a disruptive technology as the robotic and artificial intelligence (AI) one, could be a good opportunity to employers up skills, not only in soft skills [4], but in technological and digital knowledge.

Work supported under the European project TERRINet (H2020-INFRAIA-2017-1-two-stage-730994) and the Spanish State Research Agency through the ROCOTRANSP project (PID2019-106702RB-C21 / AEI / 10.13039/501100011033))

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From these perspectives, it seems interesting to investigate the influence of robotics in the job market where human and robots work together, and analyzing the HRI tasks categories and roles that human will perform in specific robotic scenarios.

Coordinating social and technological analysis is not easy. The objectives are different, sometime complementary, the researchers belong to different knowledge areas and the conclusions pointed different audiences. These socio-technological studies need specific methodology, including new procedures and a coordinated participation of different stakeholders [5]. In this article, a qualitative procedure inspired in Delphi methodology [6] is used to study and systematically approach the analysis of the human roles and tasks categories in future HRI scenarios, which will be used to validate the new proposed human roles and tasks and to look for homogenization of them in different scenarios.

In order to do this work, this article is structured in several sections. Section II makes a short state of the art. Section III presents the new methodlogical approach using the TERRINet HRI Template for analyzing human roles in HRI scenarios. Section IV analyze two study cases - in Healthcare and Urban scenarios - using this Template. Section V extend this study to 20 study cases and presents some discussion of the analysis, and finally, section VI presents the conclusions.

This research article has been done in the framework of the TERRINet EU project (www.terrinet.eu), by the TERRINet's robotic teams of the infrastructures, under the coordination of the Universitat Politècnica de Catalunya (UPC).

II. State of the art

Experts estimate that around half of today's work activities could be automated by 2055 [3]. The reason is that robotics and AI offer a wide range of potential benefits to organizations and can include cost reduction, productivity gains, enhanced reliability, scalability, improved compliance and security [7]. These wide range of benefits has a counterpart in human workers and employers well-being. Along with other factors such as globalization, the introduction of new technologies has been found to change the jobs that are available and the skills those jobs require. Empirical studies demonstrate that digital technology – not robotic - has led to a decline in the relative demand for routine jobs in advanced economies [8].

A huge part of the literature reviewed on robotics and work forces is principally addressed to healthcare and hospitality

services scenarios and mostly in social science publications, examining the impact of robots on services employers [3]; offering a huge analysis about the current state of Artificial Intelligence and Robots in technological trends, ethical questions and regulatory issues [9]; analyzing customers' acceptance and end user responses [10] or establishing the design of robots for good human acceptance [11].

With respect to the human roles and tasks in HRI scenarios several interesting articles addresses these issues.

Steinfeld [12] introduced five task categories oriented to the work of humans with mobile robots. The tasks where selected because they can be performed with a high-level of human direction (pure tele-operation), a high-level of robot independence (full autonomy), or at any point on the interaction spectrum. Using these tasks they where able to define generic metrics that can be applied to a wide range of HRI scenarios and can be used to asses the impact of different levels or types if HRI on performance.

Another important work was published by Scholtz [13] who described the human roles in HRI scenarios. He made a precise description of each role, which allow to understand the interaction and collaboration between human and robot and open new possibilities about how to integrate the best of both capabilities.

Finally, from the perspective of evaluating HRI scenarios, the work of [14] presents an analysis of the team performances in the field and control room at the DARPA robotic challenge trials.

III. The TERRINet HRI template for analyzing human roles in HRI scenarios

As we have mentioned before, the aim of this article is to define a methodology to analyze the human roles and tasks categories in diverse robotic scenarios in order to understand which are the required human and robotic activities and also to look for the homogenization of roles among the scenarios. We have created a specific template, which is denominated TERRINet HRI template, that incorporates the basic information of the robotic tasks and the specific tasks that has to be done by each one of the involved human roles.

The TERRINet HRI template was elaborated through a set of rounds with robotic teams and end users, using a research methodology characterized by the analysis of the problem in its own context [15], where the concepts are at the same time, the "inputs" and "outputs" of the research, and they are refined during the field work.

The first Template was structured in the following 4 sections:

- Current scenario description;
- Robotic scenario description and new operational procedure and activities;
- HRI Tasks performed in each activity: navigation, perception, management, manipulation and social
- HRI Roles: Supervisor, operator, mechanic, peer and bystander,

In the first Template we used the same HRI tasks categories defined by Steinfeld [12] and the same human roles defined by Scholtz [13].

TERRINet JOBs TEMPLATE

USE CASE - SCENARIO					
Current Operational Procedure					
ROBOTIC USE CASE DESCRIPTION					
Type of Robot					
Navigation					
Transporting					
Communication					
Interfaces					
Cloud Services					
Robotic Operational Procedure and Activities					
Human Robot Interaction TASKS in Robotized Scenario					
In those SCENARIOS where humans, robots and artificial systems work together, there is a shared understanding of each other's abilities, goals and current capacities, based on what they can do best to achieve a common goal. In order to analyze the HUMAN ROBOT INTERACTION in a robotized scenario, we will describe the specific activities of the operational procedure through a group of shared HARI TASKS: navigation, perception, management, manipulation, teleoperation, data management and social tasks. Each task includes general issues, that could be standardized, and specific ones that make up the robotized scenario. Data protection, safe and security measures and risk prevention are considered in all the activities. ***INCLUDE ANY OTHER TASK THAT IS REQUIERED IN THE ROBOTIC USE CASE***					
HRI TASKS	**Activity 1**	**Activity 2**	**Activity 3**	**Activity 4**	**Activity n**
NAVIGATION					
PERCEPTION					
MANAGEMENT					
MANIPULATION					
SOCIAL					
DATA MANAGEMENT					
Human Robot Interaction ROLES in Robotized Scenario					
In the previous section we have described the new robotized scenario, the specific activities that humans will perform and the HRI tasks. In this section we will describe the HUMAN ROBOT INTERACTION ROLES that will participate in the development of these activities. ***INCLUDE ANY OTHER ROLE THAT IS REQUIERED IN THE ROBOTIC USE CASE***					
HRI ROLES	**Activity 1**	**Activity 2**	**Activity 3**	**Activity 4**	**Activity n**
EXPERT SUPERVISOR					
TECHNICAL SUPERVISOR					
OPERATOR					
MECHANIC					
PEER TEAMMATE					
PEER END USER					
BYSTANDER					
TRAINER					
MENTOR					

Fig. 1: The final version of the TERRINET HRI Template.

We used this Template to analyze two different robotic scenarios: Robotic Geriatric Assessment [16], in the healthcare assistance scenario and Robotized Sewer Inspection [17], in the urban surveillance and inspection scenario. After the first rounds with this Template in the two robotic scenarios working with the robotic team and the end users, we realized that these tasks and human roles where not enough. Then, we incorporated new tasks categories and human roles and we modified the Template. We used the new Template in 18 new scenarios, and again we introduced new modifications and finally we obtained the final version of the TERRINet HRI template that can be seen in Fig. 1.

The final Template expands the task categories in 6 categories: navigation, perception, management, manipulation, social and data management. The new task category is "Data management", which includes all the treatment of the data collected in the activity and treated in the Cloud Services.

With respect to the human roles, the final Template expand them in 9 categories: expert supervisor, technical supervisor, operator, mechanic, peer teammate, peer end user, bystander, trainer and mentor. These new human role categories allow us to incorporate new important human roles that were not considered previously.

IV. Analysis of two study cases using the TERRINet HRI Template

In this section we analyzed two HRI scenarios: Robotic Geriatric Assessment [16], in the healthcare assistance scenario and Robotized Sewer Inspection [17], in the urban surveillance and inspection.



Fig. 2: Images of the Robotic Geriatric Assessment study case [16].

In both study cases, the analysis was done through a set of rounds by robotic teams and end users [18].

A. HRI Tasks and Roles in Robotic Geriatric Assessment study case

The mission in this HRI scenario is to perform a Comprehensive Geriatric Assessment (CGA) test to the patients in a geriatric center. The project focuses on the development of a mobile robot able to receive the patient and its family, accompany them to the waiting room and then to the medical consulting room. At the waiting room, some robotic activities are performed, for example the registration data and tests and, once at the medical consulting room, the robot helps the physician to capture and manage the data of the Comprehensive Geriatric Assessment (CGA) procedures.

The activities of the new operational procedure using HRI tasks are (Fig. 2):

- Semi-autonomous tele-operated guiding and accompanying
- Semi-autonomous tele-operated on line data acquisition
- Off line clinician analysis, care planning and management. Not included in HRI tasks.
- Operational procedure supervision
- Robot maintenance, hardware and software updates

The activities mentioned before were described through the group of *HRI tasks categories* defined in the Template.

In the rest of this section, we will describe the activities of each one of the *HRI human roles* for this specific study case, including the new human roles categories described before.

Supervisor. The analysis of this study case offers two different supervisor roles: expert and technical supervisor.

Expert supervisor: The current legislation in medical services, imposes to have a medical professional as the responsible of any medical action with patients and every procedure and task has to follow a specific protocol. This expert supervisor has a general information about the HRI robotic tasks: management, social and data management. The medical supervisor leads the preparation of all the procedures and checks the feedbacks of the human robot interaction (the relation between human and robot), and looks for improving or changing the current procedure and protocols. In this study case, the expert supervisor is a doctor or medical professional.

The *Technical supervisor* assists the medical supervisor, control the missions and proposes changes and improvements in the procedure. Moreover, he/she overview the situation, including progress of the multiple platforms - the mission or task plan - and the current behaviors of any of the robots including deviations that may require intervention. The technical supervisor should have deep knowledge about navigation, perception, management and data management HRI tasks and about the robots' characteristics, functionalities and specificity. A pilot license to control the robot is not mandatory if the supervisor won't tele-operate the robot. The technical supervisor could be a technician (that can include the operator role) or a healthcare professional with technical robotic knowledge.

Operator. In this case study the operator role must be a skilled user, having knowledge about navigation, perception, tele-operation, management, data management and social HRI tasks. Also the operator should have knowledge of the robot architecture and characteristics and the robot programming. A pilot license should be considered. The operator could tele-operate the robot or a group of robots in complex situations. The robot should be programmed before the execution of the task. A general overview of the state of robot could be done by the operator before the task starts, but normally the operator explains the problems to the technician that will do the periodic maintenance or repair.

Mechanic. This role includes hardware and software maintenance. It could be done by internal maintenance service or external one (a maintenance contract should be mandatory). It includes the mechanical, electronic and software settings of the robot. The mechanic should know the robots' characteristics, functionalities and specificity.

Peer. The analysis offers two different peer roles: peer teammate and peer end user.

In this specific study case, the *Peer teammate* is a healthcare professional (clinician-nurse) that will introduce the robot to the patient and his family. The peer teammate contributes to the team human-robot according to his ability, exhibiting social competences as interaction characteristics, persuasiveness, trust, engagement, including basic information about navigation, social and management. Any question or problem between robot and patient could be solved by him/her in short term.

The *Peer end user* is the patient. The patient and her/his family will establish a new relationship with the robot. This HRI human role should have information about the robotic scenario, the data management, the basic characteristics of the robot that will attend him/her and the social HRI tasks that the robot offers. The understanding of social communication and the designed interface are the key characteristics for a successful HRI.

Bystander. Along the guiding and accompanying activity, the robot will contact with diverse people at the corridors and waiting rooms. The bystander should know that the scenario includes robots and AI, the characteristics and behaviors of robots including the social HRI tasks. The creation of information tools as videos, posters and flyers could be advisable solutions for this human robot interaction stating.

Two new HRI roles – *Expert supervisor* and *Peer end user* - and a new HRI task – *Data Management* - have been detected in this scenario and included in the Template for

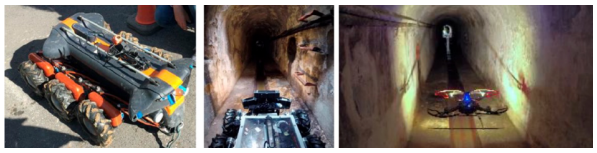


Fig. 3: Images of the Sewer Inspection study case [17].

the following analysis.

B. HRI Tasks and HRI Roles in Robotized Sewer Inspection study case

The mission in this HRI scenario is to inspect the sewer infrastructure using robots and a team workers. The current activities are performed by brigades that do inspection tasks 8 hours a day in the accessible sewer infrastructure (Fig. 3). The new operational procedure is a collaborative job between humans and robots to determine the state of the sewer by identifying the sewer segments where their functionalities have been reduced due to sediments or structural defects. The robot has to register images, videos and has to do geometric analysis (scanning). Additionally, the robot has to take samples of the water, air and sediments for monitoring them and do structural defect inspection. GIS cartography could be another functionality for those networks which do not have [19].

The robotized sewer inspection' operational procedure includes: logistics; programming trials; inspection (video and images analysis); off line data analysis and management; operational procedure supervision; and robot maintenance. As we have done before, once we have described the HRI tasks to be performed in this new robotic scenario, we will analyze the human roles and the tasks involved in this scenario.

Supervisor. This role could join expert and technical supervision. In this activity is mandatory to have a procedure overview, to know the robot capacities, the tele-operation performance and the results of the full process aligned to the inspection requirements. The supervisor should know navigation, perception, management and data management HRI tasks in order to participate in the trials program and could do the off line data analysis and management. In Human-Robot Interactions the physical capabilities of the system change and the supervisor needs to know the "normal" status of the robot at any given time. The supervision operation will organize the process and check it in a continuous improving plan.

Operator. During the trials, the robot could go in autonomous mode or in tele-operated mode with remote interaction. In this case the operator will do tele-operation with knowledge in navigation, perception, manipulation, management and data management HRI tasks. This activity includes knowledge about the robot, sensors, and the robot plans. The management could include a team of robots that collaborate between them. The operator must be a skilled user, having knowledge of the robotic architecture and robotic programming. The operator should pilot the robot or robots and should be capable of supporting interaction in a complex situation. The pilot license could be mandatory. This role shares information with the supervisor and vice versa.

ROBOTIC SCENARIO	STUDY CASES
HEALTHCARE ASSISTENCIAL	**Robotized Geriatric Assessment**
	Robot-mediated rehabilitation
HEALTHCARE TELEOPERATED INTERVENTIONS	**Robot assisted minimally invasive surgery**
	Micro Robots for liquid biopsy
	Cathbot
INFRASTRUCTURES MAINTENANCE AND INSPECTION	**Robotized Sewer Inspection**
	Work at height in industrial facilities
	Inspection and maintenance of power lines
URBAN SURVEILLANCE AND LOGISTICS	**Human-Friendly Drone Delivery System for last centimeter delivery**
	Drone assistance for police in handling burglaries
INDUSTRIAL OPERATIONS	**Adaptive robotic cell for SPC**
INDUSTRIAL COWORKERS	**Safe screwing with the collaborative robot**
	Augmented reality instructions projected on workpieces
	Manipulation of heavy parts
	Manipulation of the deformable objects
	Involving mobile robots in assembly tasks in aircraft factory
	The Cognitive and Interactive Robot co-worker
DRONE TELEOPERATION	**FlyJacket for drone control**
AGRICULTURAL	**Building a vine pronnunig unit and assembling it with an autonomous viticultural machine**
EDUCATION	**New possibilities for middle school teachers in computer science lessons**
MILITARY MANIPULATION	**Explosive ordinance disposal in the German military**

Fig. 4: Table of the 20 study cases

Mechanic. This activity includes hardware and software maintenance. In these inspection scenarios were the trials could damage the robots, a technician, with robotic knowledge, could help the development of the operational procedure. As we have seen before, usually the robot will be sent to the manufacturer for any update or big repair.

Peer Teammate. This role includes knowledge about the robot navigation, operation and maintenance. It could be assumed by the operator. The current brigades could develop this role and could up skill their competences to perform the operator role.

As we have seen before, the robot maintenance includes hardware and software maintenance and could be done by an internal or external team.

V. HRI HUMAN ROLES IN ROBOTIZED SCENARIOS. 20 STUDY CASES

We have analyzed 20 study cases that where prepared by the TERRINet partners in their infrastructures. These study cases can be seen in the table of Fig. 4.

For each one of these study cases we analyzed the HRI human roles and tasks. Fig. 5 shows the human roles for the diverse study cases. The human roles, expert and technical supervisor, operator, mechanic and peer teammate appear in almost all the cases, while the other roles appear occasionally.

We also analyzed what type of HRI task categories are required for each one of the human roles in all the study cases. Fig. 6 shows the analysis for healthcare assistance scenarios and Fig. 7 shows the analysis for the healthcare teleoperated interventions.

One of the important issues in the analysis of human roles, it is the study of which of the human roles can be homogenized among diverse scenarios or missions. In this research,

ROBOTIC SCENARIO	STUDY CASES	EXPERT SUPERVISOR	TECHNICAL SUPERVISOR	OPERATOR	MECHANIC	PEER TEAMMATE	PEER END USER	BYSTANDER	MENTOR	TRAINER
HEALTHCARE ASSISTENCIAL	Robotized Geriatric Assessment	■	■	■	■	■	■	■		
	Robot-mediated rehabilitation	■	■	■	■	■	■	■	■	■
HEALTHCARE TELEOPERATED INTERVENTIONS	Robot assisted minimally invasive surgery	■		■	■	■			■	■
	Micro Robots for liquid biopsy	■	■	■	■	■	■			
	Cathbot	■	■	■						
INFRASTRUCTURES MAINTENANCE AND INSPECTION	Robotized Sewer Inspection	■	■	■	■	■				
	Work at height in industrial facilities	■	■	■	■	■	■			
	Inspection and maintenance of power lines	■	■	■	■	■				
URBAN SURVEILLANCE AND LOGISTICS	Human-Friendly Drone Delivery System for last centimeter delivery	■	■	■	■		■			
	Drone assistance for police in handling burglaries	■	■	■	■	■				
DRONE TELEOPERATION	FlyJacket for drone control	■	■	■	■					
AGRICULTURAL	Building a vine pruning unit and assembling it with an autonomous viticultural machine	■	■	■			■			
EDUCATION	New possibilities for middle school teachers in computer science lessons	■	■	■	■	■				
MILITARY MANIPULATION	Explosive ordinance disposal in the German military	■	■	■						

Fig. 5: Analysis of human roles in the study cases

HUMAN ROBOT INTERACTION ROLES IN HEALTHCARE ASSISTANCE SCENARIOS		
TASKS AND HUMAN ROLES IN HRI SCENARIOS	ROBOTIZED GERIATRIC ASSESMENT	ROBOT MEDIATED REHABILITATION
		
EXPERT SUPERVISOR	MANAGEMENT / SOCIAL / DATA MANAGEMENT	NAVIGATION / PERCEPTION / SOCIAL / MANIPULATION
TECHNICAL SUPERVISOR	MANAGEMENT / DATA MANAGEMENT	PERCEPTION / MANIPULATION / SOCIAL / MANAGEMENT / DATA MANAGEMENT
OPERATOR	NAVIGATION / PERCEPTION / MANAGEMENT / SOCIAL DATA MANAGEMENT	NAVIGATION / PERCEPTION / SOCIAL / MANIPULATION / MANAGEMENT / DATA MANAGEMENT
TECHNICIAN / MAINTAINER	ROBOT MAINTENANCE	ROBOT MAINTENANCE
PEER TEAMMATE	NAVIGATION / SOCIAL / MANAGEMENT	NAVIGATION / PERCEPTION / DATA MANAGEMENT
PEER END USER	ROBOT INFORMATION	ROBOT INFORMATION
BYSTANDER	SCENARIO INFORMATION	SCENARIO INFORMATION
TRAINER		TEACHING
MENTOR		TEACHING

Fig. 6: Analysis of tasks categories and human roles in healthcare assistance scenarios

HUMAN ROBOT INTERACTION ROLES IN HEALTHCARE TELEOPERATED INTERVENTIONS			
TASKS AND HUMAN ROLES IN HRI SCENARIOS	ROBOTIC MINIMALLY INVASIVE SURGERY	RADIATION –FREE ROBOTIC ENDOVASCULAR INTERVENTIONS	MICRO-ROBOTIC ASISTED ANALYSIS
			
EXPERT SUPERVISOR	NAVIGATION / SOCIAL / PERCEPTION / MANAGEMENT / MANIPULATION / DATA MANAGEMENT	MANAGEMENT / MANIPULATION / MANAGEMENT	NAVIGATION / PERCEPTION / MANIPULATION
TECHNICAL SUPERVISOR		ROBOT MAINTENANCE	NAVIGATION / PERCEPTION / MANIPULATION/ DATA MANAGEMENT
OPERATOR	NAVIGATION / MANIPULATION / PERCEPTION / MANAGEMENT / DATA MANAGEMENT	PERCEPTION / SOCIAL / MANAGEMENT / MANIPULATION / DATA MANAGEMENT	NAVIGATION / PERCEPTION / MANIPULATION
TECHNICIAN / MAINTAINER	ROBOT MAINTENANCE	= TECHNICAL SUPERVISOR	ROBOT MAINTENANCE
PEER TEAMMATE	NAVIGATION / SOCIAL / PERCEPTION / MANAGEMENT / MANIPULATION / DATA MANAGEMENT	PERCEPTION / MANAGEMENT / MANIPULATION / SOCIAL / DATA MANAGEMENT	
PEER END USER		ROBOT / ROBOTIC SCENARIO INFORMATION	
BYSTANDER			
TRAINER	NAVIGATION / PERCEPTION / MANAGEMENT MANIPULATION / SOCIAL / ROBOT MAINTENANCE	TEACHING	
MENTOR	NAVIGATION / PERCEPTION / MANAGEMENT / SOCIAL / MANIPULATION / DATA MANAGEMENT	TEACHING	

Fig. 7: Analysis of tasks categories and human roles in healthcare teleoperated interventions

we realized that this is a very difficult topic, but in some cases we found that exist some type of homogenization. Fig. 8 shows that in the case of urban infrastructures inspection and maintenance scenarios, we can find homogenization of human roles trough common task categories.

In the analysis of the study cases, we discovered new HRI human roles, specifically in Healthcare Tele-operated Interventions scenario where the robot is fully operated by the medical or surgical professional, two new human roles were required: Mentor and Trainer.

Mentor is a counselor or guide expert that establishes a personal development relationship that helps a less experienced or less knowledgeable person. The mentor could be assimilated as an expert supervisor, but including tasks of training and teaching for a period of time.

Trainer is a person that prepares or trains people for the practice of a specific task. The robot manufacturer is who usually prepare this human role.

Other human roles appear besides the ones related with the HRI ones: robot designers (hardware and software); interface and communication designers; HRI trainers specifically for social tasks; and robotic set designers for each scenario where human and robots will interact and collaborate.

New business models will also appear linked to the robotic scenarios. For example, in last mile delivery use case, Small and Medium Companies (SMEs) could develop commercial solutions.

In all the HRI human roles, including the bystander, all people have to be prepared to work with robots or at least to know their characteristics and functionalities. Information

HUMAN ROBOT INTERACTION ROLES IN URBAN INFRASTRUCTURES INSPECTION AND MAINTENANCE SCENARIOS			
TASKS AND HUMAN ROLES IN HRI SCENARIOS	ROBOTIC SEWER INSPECTION 	INSPECTION AND MAINTENANCE OF POWER LINES 	WORK AT HEIGHT IN INDUSTRIAL FACILITIES 
EXPERT SUPERVISOR & TECHNICAL SUPERVISOR	MANAGEMENT / NAVIGATION / MANIPULATION / PERCEPTION	MANAGEMENT / NAVIGATION / MANIPULATION / PERCEPTION	MANAGEMENT / NAVIGATION / MANIPULATION / PERCEPTION
OPERATOR	NAVIGATION / MANAGEMENT / PERCEPTION / MANIPULATION / DATA MANAGEMENT	NAVIGATION / PERCEPTION / MANIPULATION / MANAGEMENT / DATA MANAGEMENT	NAVIGATION / MANAGEMENT / PERCEPTION / MANIPULATION / DATA MANAGEMENT
TECHNICIAN / MAINTAINER	MAINTENANCE	MAINTENANCE	MAINTENANCE
PEER TEAMMATE	ROBOT MAINTENANCE / NAVIGATION	LOGISTICS / NAVIGATION / MANAGEMENT	LOGISTICS / NAVIGATION / MANAGEMENT

Fig. 8: Scenarios where the homogenization of human roles among different missions can be done through common task categories

and dissemination actions have to be prepared to educate the people about this new robotic technology revolution and prepare people for the new Human Robot Interaction scenarios.

VI. Conclusions and Future Research Proposals

In this article we have explained a new methodological approach to analyze Human-Robot Interaction scenarios. We have created a document that can help to do this process, which is denominated TERRINet HRI Template. This Template includes the description of the HRI task, the human roles and task categories. The Template uses 9 human roles to describe the activities: expert supervisor, technical supervisor, operator, mechanic (hardware and software), peer teammate, peer end user, bystander, mentor and trainer,. The Template also uses 6 HRI task categories: navigation, perception, manipulation, management, social and data management.

Using this template an methodological procedure, we have analyzed 20 study cases in diverse fields: healthcare assistance and teleoperated interventions; infrastructures maintenance and inspection; urban surveillance and logistics; drone teleoperation; education; agriculture vine branch pruning; military manipulation; and industrial co-workers.

For these study cases we could determine the human roles and their corresponding task categories. For the urban infrastructure maintenance and inspection, we have been able to find homogenization of the human roles.

Finally, this new methodologically approach can be extended to new HRI scenarios, where new human roles and task categories can be found. These new roles will imply new human abilities, new jobs, and new education and training for these jobs.

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