LCAMP

Learner Centric Advanced Manufacturing Platform

Robotics

WPN° 3 Observatory

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LCAMP partners:

TKNIKA – Basque VET Applied Research Centre, CIFP Miguel Altuna LHII, DHBW Heilbronn – Duale Hochschule, Baden-Württemberg, Curt Nicolin High School, AFM – Spanish Association of Machine Tool Industries, EARLALL – European Association of Regional & Local Authorities for Lifelong Learning, FORCAM, CMQE: Association campus des métiers et des qualifications industrie du future, MV: Mecanic Vallée, KIC: Knowledge Innovation Centre, MADE Competence Centre Industria 4.0; AFIL: Associazione Fabbrica Intelligente Lombardia, SIMUMATIK AB; Association HVC Association of Slovene Higher Vocational Colleges; TSCMB:Tehniški šolski center Maribor, KPDoNE: Kocaeli Directorate Of National Education; GEBKİM OIZ and CAMOSUN college.

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GLOSSARY AND/OR ACRONYMS

AI - Artificial Intelligence

AM - Advanced Manufacturing

Cedefop - European Centre for the Development of Vocational Training

CoVE - Centres of Vocational Excellence

EAfA - European Alliance for Apprenticeships

EC - European Commission

ECVET -European Credit System for Vocational Education and Training

EntreComp - The Entrepreneurship Competence Framework

EQAVET - European Quality Assurance in Vocational Education and Training

EQF - European Qualifications Framework

ESCO - European Skills, Competences and Occupations

ETF - European Training Foundation

EU - European Union

HE - Higher Education

HVET - Higher Vocational Education and Training

I4.0 - Industry 4.0

KET - Key Enabling Technology

OECD - Organisation for Economic Cooperation and Development

SME - Small and Medium Enterprises

SWOT - Strengths, Weaknesses, Opportunities, Threats

TVET - Technical and Vocational Education and Training

VET - Vocational Education and Training

WBL - Work Based Learning

CONTENT TABLE

EXECUTIVE SUMMARY

Advanced Manufacturing (AM) and Higher Vocational Education and Training (HVET) need to update training, implement new technologies, and get quick access to data.

The causes behind these needs are technological factors (Industry 4.0), factors conditioned by education systems and education methodologies, social factors and environmental factors (the European Green Deal with its emphasis on the greening industry).

Under the CoVE initiative, the LCAMP project aims to support regional skill ecosystems and various stakeholders in providing new skills and implementing new or updated technologies in VET centres. LCAMP will tackle this by incorporating a permanent European Platform of Vocational Excellence for Advanced Manufacturing.

By collaborating across borders, LCAMP's goal is to support and empower regional Advanced Manufacturing CoVEs to become more resilient, innovative, and better equipped to train, upskill, and reskill young and adult students, to successfully face the digital and green transitions. We will help European regions and countries grow and be more competitive through their VET systems.

Therefore, the LCAMP OBSERVATORY is one of the services in the LCAMP platform. The observatory is led by the French cluster *Mecanic Vallée* and the French VET provider *Campus des Métiers et des Qualifications d'Excellence Industrie du Futur*.

This present document details the first results of the LCAMP Observatory, through the methodology that the LCAMP consortium used to set up and run the Observatory. We had set up a process cycle for the observation consisting of 5 stages:

- Stage 1: Diagnosis and priority
- Stage 2: Search and information gathering
- Stage 3: Information Analysis
- Stage 4: Creating value. Elaboration of LCAMP reports
- Stage 5: Dissemination and communication.

1. INTRODUCTION

The LCAMP observatory is one of the services of the LCAMP platform.

The LCAMP Observatory must be a reliable and easily accessible source of information and data for trainers, VET teachers, and professionals, updated on Digital / Advanced Manufacturing / Smart Industry, delivered through a multimedia and interactive platform -LCAMP platform-, that can be customized according to individual interests (Work in progress in WP8).

This observatory must feed other Work packages (WP), for instance, WP 5 on Learner Centric Training, or Open innovation Community in the WP4.

In a first document about methodology, are set up a process cycle for the observation consisting in 5 stages:

- Stage 1: Diagnosis and priority
- Stage 2: Search and information gathering
- Stage 3: Information Analysis
- Stage 4: Create value. Elaboration of LCAMP reports
- Stage 5: Disseminate-communicate.

Following this process cycle, are detailed the main aspects of the observation methodology:

- Identify reliable sources that we can find in Europe about Advanced Manufacturing.
- Classify and filter data gathered from different sources.
- Present several ways to collect data and to analyse them.
- Define the methods for the creation of annual reports.
- Validate process for those reports.

The observatory will publish periodical reports for VET and HVET target audiences about technology trends, labour market changes, skill needs, and occupations in Advanced Manufacturing. It is expected that SMEs, industry clusters and other associations will also find valuable information in the observatory.

The publication of a yearly report is planned.

- Report 1: June 2023,
- Report 2: June 2024,
- Report 3: June 2025.

This first annual report is gathering sub-reports written by around twenty different writers, from the main partners involved in the LCAMP project. 39 Topics were determined, and 22 TOPICS were analysed and worked on during this first period.

2. TOPIC: TECHNOLOGY TRENDS IN ROBOTICS

The purpose of this chapter is to present some of the development areas related to AM.

These are topics that concern all or some of the stakeholders

- CoVEs and VETs: teachers, trainers and heads of VET schools;
- Learners: students, active workers, job seekers;
- Companies;
- Policy makers and other stakeholders

The field of Robotics will have a large Influence on Future Trends in Advanced manufacturing. In these different areas we are observing different trends.

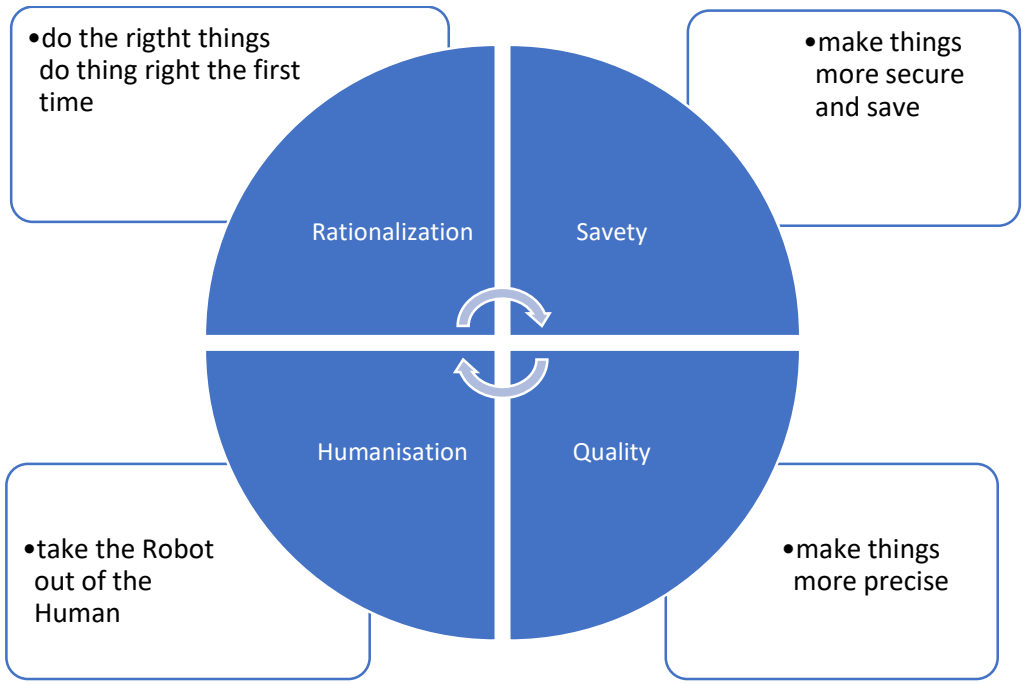

Figure 1 : Objectives

- Industrial Robots
  - Serial Robots, Parallel Robots, Mobile industrial Robots, Cobots
- Service Robots
  - Programmable systems,
  - Autonomous Systems
- Entertainment Robots

- Toys, Humanoid Robots, Marketing Robots, Art Robots

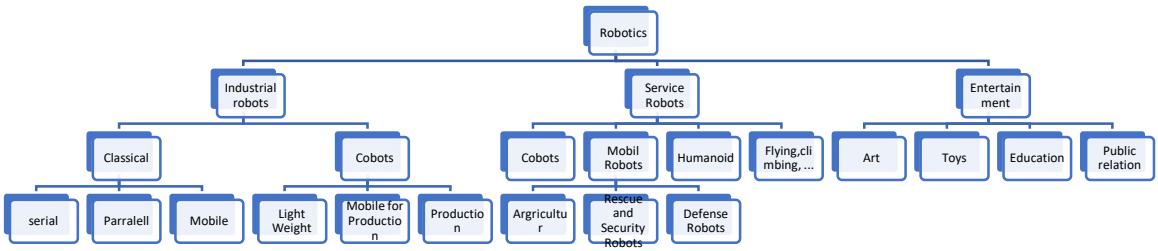

Figure 2 : Uses of robotics in different fields

2.1 INTRODUCTION

- Why is relevant for VET, why we have chosen (this topic), also what we are going to describe about it in this sub report, how the sub report is organized.
- Robotics is becoming increasingly relevant for vocational education and training (VET) because of the growing demand for workers with skills in this field. As automation and artificial intelligence continue to transform many industries, there is a need for workers who can design, program, operate, and maintain robots and other automated systems.
- Moreover, the use of robotics is becoming more prevalent in various industries, such as manufacturing, healthcare, agriculture, and logistics. These industries need skilled workers who can integrate robotics technology into their work processes and optimize their efficiency.
- VET institutions can provide students with the necessary skills and knowledge to work with robots and automated systems. This can include programming, troubleshooting, and maintenance of these systems. Robotics training can also help students develop important skills such as problem-solving, critical thinking, and teamwork, which are essential in many workplaces.
- The relevance of robotics in VET is driven by the need for skilled workers in industries that are increasingly using automation and robotics technology. Robotics training can provide students with the skills and knowledge they need to succeed in these fields and help them develop important transferrable skills.
- Robotic technology is highly relevant for vocational education and training (VET) for several reasons:
- Job opportunities: Robotics is becoming an increasingly important field in the modern workforce, with more and more companies seeking individuals with expertise in robotics.

VET programs that offer training in robotics provide students with the skills and knowledge needed to succeed in this growing field, making them more employable.

- Industry demand: Many industries, such as manufacturing, logistics, and healthcare, are starting to adopt robotics to automate tasks, improve efficiency, and reduce costs. By teaching students about robotics, VET programs can help meet the industry demand for skilled workers in this area.
- Hands-on learning: Robotics offers a highly interactive and hands-on learning experience, which can be engaging and motivating for students. This type of learning allows students to apply theoretical concepts in a practical setting, which can help deepen their understanding and develop their problem-solving skills.
- Future-proofing skills: As robotics becomes more prevalent in various industries, it is important for VET programs to incorporate this technology into their curricula. By doing so, VET programs can help future-proof students' skills, ensuring that they are equipped with the knowledge and competencies needed to succeed in a rapidly changing job market.
- Robotics is highly relevant for VET because it offers students the opportunity to gain valuable skills and knowledge that can increase their employability and future-proof their career prospects.

Presentation and brief description of the topic.

Robotics is a multidisciplinary field that covers a wide range of applications and industries. Here are some of the main fields that robotics covers:

F1: Trends: This field focuses on the latest trends and innovations in robotics, including new technologies, emerging applications, and market trends. It involves tracking and analyzing developments in the robotics industry, and predicting future directions and opportunities.

F2: Impact on jobs: This field focuses on the impact that robotics is having on the workforce, including changes to job roles, job displacement, and new job opportunities. It involves analyzing the effects of automation and robotics on different industries and occupations, and identifying strategies for managing these impacts.

F3: Skills & Qualifications: This field focuses on the skills and qualifications that are required for careers in robotics, and the education and training pathways that can prepare individuals for these careers. It involves identifying the core competencies needed for robotics-related jobs, and developing training programs that can provide students with these skills.

F4: Future Skills: This field focuses on the future skills that will be required as robotics continues to evolve and advance. It involves predicting the skills and knowledge that will be needed for future robotics-related jobs, and identifying ways to develop these skills through education and training programs.

Other fields that robotics covers include:

Industrial automation: This field focuses on the use of robotics in manufacturing and industrial processes, including applications such as material handling, assembly, and quality control.

Service robotics: This field focuses on the use of robotics in service industries, such as healthcare, hospitality, and retail, where robots are used to perform tasks such as cleaning, food service, and customer assistance.

Human-robot interaction: This field focuses on the design and development of robots that can interact with humans in natural and intuitive ways, including applications such as social robots, educational robots, and assistive robots.

Robotics engineering: This field focuses on the design, development, and testing of robotic systems, including aspects such as robotics mechanics, control systems, and sensors.

Robotics ethics: This field focuses on the ethical and social implications of robotics, including issues such as privacy, safety, and the impact of robotics on human society.

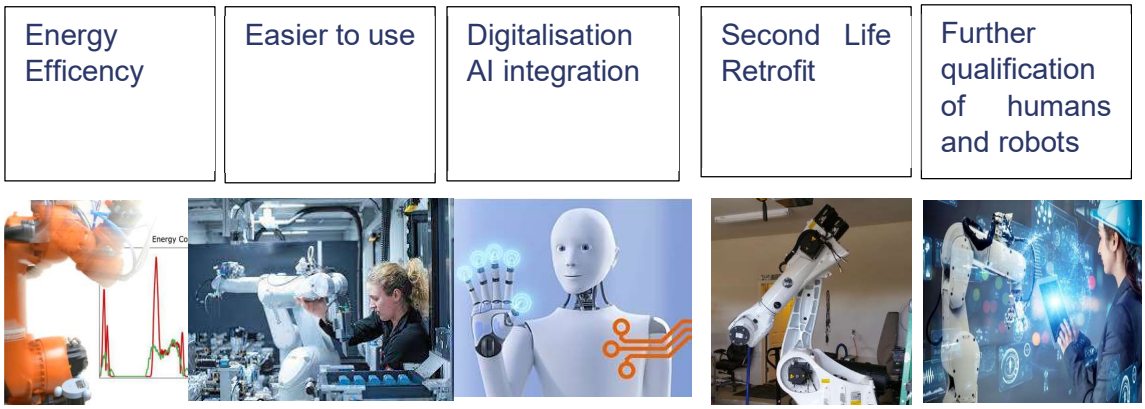

Figure 3 Trends in Robotics

2.2 CONTEXTUALISATION

The same topic can have a huge number of perspectives. We will choose some of those "perspectives" and we must explain it, we must determinate the scope of our work

For instance, if the topic is robotics. Contextualization would be:

Example 1: Competences and skills associated to robot integration in digitalized industries. Transformed jobs and emerging skills.

Example 2: Integration of collaborative robotics in VET labs. Approaches for education of robotics in VET centres (EQF 3-6) Use cases.

Example 3. Reference centres of robotic education the VET system in Spain.

Example 4 Job transformations due to the integration of robotic systems (robots, cobots, avg) in SMEs in the automotive sector in Spain. Qualitative and quantitative analysis

Example 5: Technology trends in robotics.

The topic in all those examples is robotics but the contents will be totally different. I think it's not enough saying: Topic + Field (F1: Trends; F2: Impact on jobs; F3: Skills & Qualifications; F4: Future Skills) + geographical scope, we need an extra context.

2.3 OBJECTIVES / RESEARCH QUESTION / PROBLEM STATEMENT :

If we have chosen a concrete topic is because there is a Challenge: Here we should describe the challenge based on the analysed information (using references). Normally it will be a big part of the "sub report"

2.3.1 OBJECTIVES

The objectives of this work are to understand how the topic sector is evolute, what are its trends, and what changes can be expected in that sector.

2.3.2 RESEARCH QUESTION

Analysis of the important elements (growth or gold brakes ...) detected in the Objectives.

2.3.3 PROBLEM STATEMENT

The robotic revolution will create 97 million new jobs, but communities most at risk of disruption will need the support of businesses and governments, as they become more vulnerable to being replaced over the next five years[1].

That is why so many lower tasks are left to automation: machines can do everything that can be done predictably and repeatedly today, and it simply makes no sense to waste human labour on this type of task. Currently about 1.5 million tasks, no longer depend on human labour, but that number is expected to rise as technology improves.[2]

New jobs will replace old ones, and new ones will become more popular as automation releases jobs that have been bad and boring. The robotic revolution is here, and it is creating a new industrial revolution in which humans will still play the most important role. We look forward to a future where robots will drive job growth and create exciting jobs that we cannot even imagine

[1] https://digital-skills-jobs.europa.eu/en/community/online-discussions/robots-taking-jobs-creating-careers

[2] https://www.tagesschau.de/inland/regional/badenwuerttemberg/swr-wuerth-gruppe-100.html

today.[3] welcomes it because we know that it will make our lives easier, as technology always does, and because we know that its very existence will create new jobs. [4567]

2.4 INDUSTRIAL ROBOTS

Industrial robots are universally usable moving machines with more than 3 axes, whose movements are freely programmable and sometimes sensor guided. Industrial robots can be equipped with grippers, tools or other means of production and can carry out handling and/or production tasks in an industrial environment. the market for industrial robots is largely saturated. The new installations of robots in Europe are about the number of decommissioned robots.

Industrial robotics gain a high degree of standardization. To reduce the number of spare parts and to simplify the supply chain the robot producer tries to find a modular system to realize different Robots with the same Components. Especially Gears Drives and the Controller cabinet tis common for large number of Robots.

Another trend is to simplify the operation of Robots and make it very easy for robots to be operated by less qualified personnel. Normal Workers should be able to operate a industrial Robot.[89]

Very high level of security

The socially accepted risk is increasingly reduced. The automation industry is particularly sensitive here. According to Performance Level the performance level, we always try to be higher in the pure performance phase. For the safety risk of an industrial robot, this means that a single error must not lead to the loss of the safety function. And in the case of redundant execution, a single error must be detected.

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[3] The eSkills Malta Foundation (https://digital-skills-jobs.europa.eu/en/organisations/e-skills-malta-foundation

[4] (https://digital-skills-jobs.europa.eu/en/community/online-discussions/robots-taking-jobs-creating-careers) (https://geekflare.com/digital-transformation-ai-robots-iot/)

[5] https://ifr.org/ifr-press-releases/news/top-5-robot-trends-2023

[6] https://www.ipa.fraunhofer.de/en/about-us/guiding-themes/robot-technologies-and-services/robotics-trends.html

[7] https://new.abb.com/news/de/detail/100417/abb-nennt-die-wichtigsten-robotik-trends-fur-2023

[8] https://manufacturingdigital.com/ai-and-automation/industrial-robotics-current-trends-and-future-predictions

[9] https://blog.isa.org/trends-industrial-robotics-collaboration-machines-humans

High mechanical precision

Especially in the case of industrial robots, there is a trend towards higher precision. Due to the development in the gear sector and the improved design of the mechanical structure with optimized heat transfer, industrial robots are becoming more and more precise. The repeatability is more than sufficient for modern robot applications. Absolute accuracy is becoming increasingly important as more and more applications rely on an offline process chain. The integration into real processes with different environmental conditions also forces increased absolute accuracy.

Energy Efficiency

A trend is to reduce their energy consumption and energy efficiency. This will be reached by raising the efficiency of the Drive systems including the gears. By optimizing the control cabinet and by reducing the by reducing non-value-adding energy consumption especially in the standby mode.

Resilience

The robot should have properties that allow it to realize emergency operation despite malfunctions. Move with reduced speed or accuracy. Or at least to realize a movement in a service position so that other robots can take over its service.

Trend towards smaller robots

While a few years ago larger and larger robots were introduced, the trend is more towards smaller units. This is supported by other trends such as the trend towards greater flexibility and safety. As well as by the trend towards energy efficiency. The robots have also become more efficient in the use of materials. The weight of the robots used has been reduced by more than 70%.

Kuka added to his portfolio the KR FORTEC ultra it has nearly the Performance of the KR Titan with less than have of the weight.[10]

2.5 COLLABORATIVE ROBOTICS

Cobot describes robots designed for direct interaction/collaboration with humans. If humans and robots share a workspace without a separating protective device, this is also referred to as human-robot collaboration.

Low Cost Systeme

The market for low-cost systems is very weak. If companies offer their robots in the low-cost area, they usually lack the financing for interesting further developments and integration into an environment. Especially the customer for low-cost robots is only conditionally willing to pay for technology packages and robot-related services

Very high flexibility

[10] https://www.kuka.com/de-de/produkte-leistungen/robotersysteme/industrieroboter/kr-fortec-ultra-schwerlastroboter

Cobots will not replace standard industrial Robots. They will find new areas of production to spread. Areas such as care, hospital, department stores or gastronomy will be future fields of application. In the industrial environment, fields such as setting up machine tools, quality control or maintenance and inspection are occupied by service robots.

Cobots are developed with higher Loads. In the last years many robots with a maximum Load below 10kg were established. New Cobots will have a payload of 35kg and more. This could be reached though smarter sensor systems and Load compensation. Protective case with capacitive and tactile sensors enables also classical industrial robots.[11][12]

Collaborative robots are placed on a mobile platform in order to be able to be used flexibly at different work locations. Technological integration and adaptation to weakly structured environments have so far been the main obstacles.

Intelligent Automation

A new level in the cooperation between man and machine will be enabled through intelligent automation. Smart automation is changing the business processes in companies fundamentally though AI and analytics.[13]

Goals of intelligent Automation are:

- reduce lead time
- mass customized products
- increasing transparency and thus creating trust
- increase efficiency

2.6 SERVICE ROBOTS

Service robotics is an area of robotics that focuses on the use of robots in service industries.

Service robots are specially designed robots that are designed to provide services to humans.[14]

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[11] https://www.digital-manufacturing-magazin.de/trends-der-industrierobotik-die-grosse-expertenumfrage

[12] https://www.k-zeitung.de/cobots-das-sind-die-drei-trends-auf-dem-markt

[13] https://shop.computerwoche.de/fileserver/files/2304/116210815735118/intelligentautomation_leseprobe.pdf

https://alchemmy.com/intelligent-automation/

[14] https://www.fortunebusinessinsights.com/industry-reports/service-robotics-market-101805

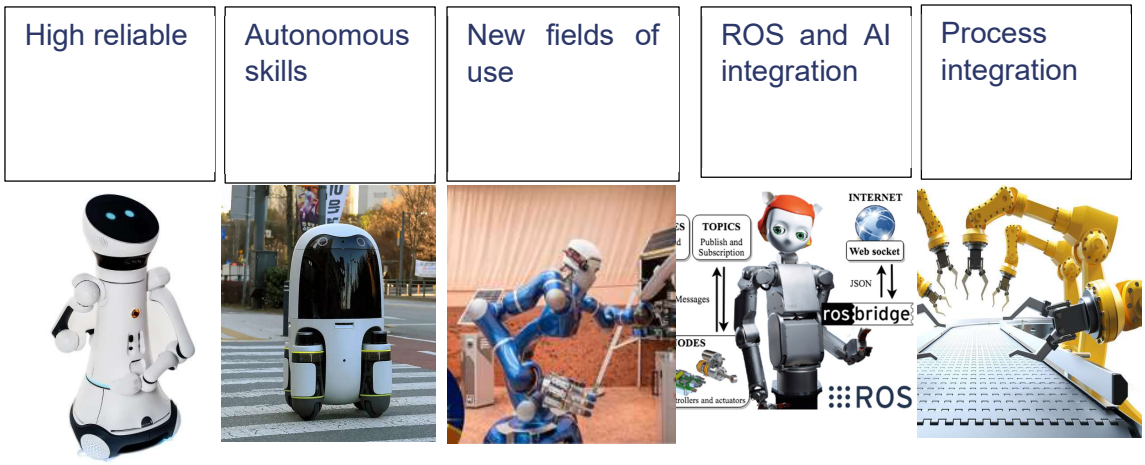

Figure 4 Trends in Service Robotics

Service Robots in new domains: These types of robots can perform tasks that are normally performed by humans, such as customer service, cleaning, transportation, monitoring, and assisting with physical labor.

Warehouses, Healthcare, Gastronomy, indoor Logistics

One example is the Turkey's robot factory for Humanoid Robots to be used in households[15]

Standardized Mechanical Platforms

To build up a mobile service Robot mainly a common platform is used like the differential drive from the Turtle Robot.[16]

On the LCAMP Platform there is also an Open Innovation area with a standardized mobile Robot using the most important Technologies like ROS.

Standardized Control systems using ROS

Standardized control systems using ROS (Robot Operating System) are pre-designed and pre-built software components that provide a foundation for building different types of robots. ROS is an open-source software framework that provides a set of tools and libraries for building robot

[15] https://www.youtube.com/watch?v=vScv-tt05Ng

[16] https://www.turtlebot.com/

applications. ROS provides a standardized way of developing software components for robots, allowing for easier integration of different hardware and software components.[17]

Cloud based collaboration

Cloud-based collaboration tools are increasingly being integrated with other collaboration tools, such as project management tools, video conferencing tools, and messaging tools. This integration makes it easier for teams to collaborate seamlessly across different tools and platforms. Cloud-based collaboration tools are increasingly offering features like real-time editing and co-authoring to support this trend. With cloud-based services the robots could use a common database. Already learned skills could be shared by all connected robots.

Healthcare robotics: There is a growing trend towards using robots in healthcare to assist with tasks such as patient care, medication management, and telemedicine. This includes robots that can help with physical therapy, provide companionship to elderly patients, and even perform surgery.

Hospitality robotics: In the hospitality industry, robots are being used for tasks such as cleaning, room service, and concierge services. For example, hotels are starting to use robots to deliver towels, pillows, and other items to guests' rooms.

Retail robotics: In retail, robots are being used for tasks such as inventory management, customer service, and product delivery. For example, some stores are starting to use robots to help customers find products, while others are using robots to deliver online orders to customers' homes.

Personal service robotics: There is also a growing trend towards using robots for personal services, such as cleaning, cooking, and lawn care. This includes robots such as vacuum cleaners, robotic lawnmowers, and robotic chefs.

The trends in service robotics are focused on providing more personalized and collaborative services to individuals, using advanced technologies such as artificial intelligence and cloud computing to improve performance and efficiency. As service robotics continues to evolve, we can expect to see even more innovative and transformative applications in a wide range of industries and settings. these trends are driving innovation and growth in the field of service

[17] https://www.mordorintelligence.com/industry-reports/robot-operating-system-market

https://www.globenewswire.com/news-release/2023/03/09/2624510/0/en/Robot-Operating-System-ROS-Market-Is-Expected-To-Reach-around-USD-0-7-Billion-by-2030-Grow-at-a-CAGR-Of-9-2-during-Forecast-Period-2023-To-2030-Data-By-Contrive-Datum-Insights-Pvt-.html

https://www.databridgemarketresearch.com/reports/global-robot-operating-system-market

robotics and are helping to create new opportunities for robots to assist and augment human workers in a wide range of service industries.[18]

Social Robots are robots designed to operate and interact with humans, in contexts similar to human–human interaction contexts. These are based on communication and empathetic interactions. They are not focused on services[19].

2.7 ENTERTAINMENT ROBOTS

Entertainment robots get a more serios area. Starting from simple Toys to high sophisticated robot demonstration planforms everything is included. In this context the toy robots dedicated for education are of special interest.

Educational robots are used in various environments to teach science, technology, engineering, and math (STEM) subjects in schools or to bring gamification in educational robots: Gamification is being used to make educational robots more engaging and entertaining for students.

Interactive exhibit robots are robots that are used in museums, galleries, and other public spaces to provide interactive exhibits that engage and educate visitors.

Performance robots are robots that are designed to perform on stage or in other public spaces, often with human-like movements and expressions, providing entertainment for audiences.

Research robots that are not mature enough for real processes deserve special mention here. They are mainly humanoid or other walking Robots with the research focus on control or Human Robot interaction. With classical wheel-based robot the research focus is on autonomous navigation.

A strict division of robots into individual categories is not possible. Individual robots can be used in several areas. The transition from entertainment robot to service robot is fuzzy. Depending on the application, whether commercial or not, the classification can look different. Typical toy robots are more and more placed as educational robots.

The time when a robot is perceived as an attraction at a trade fair is over. Rather, these robots with additional abilities move into restaurants or care homes.

[18] https://www.augsburg.tv/mediathek/video/service-roboter-bella-sorgt-fuer-begeisterung-in-gersthofen/

[19] https://www.mdpi.com/2218-6581/11/4/75

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