ARISE 1st OC - Technical Guidelines

1 Introducing the ARISE Technical Framework..... 1

1.1 Purpose, objectives, and scope of the framework..... 1

1.2 Harmonized model for Developing Industrial HRI Applications..... 1

1.3 ARISE Middleware Technologies: ROS 2 and FIWARE..... 1

1.4 ARISE's All-in-one Middleware for Industrial HRI applications in action..... 2

2 Steps to prepare a competitive proposal..... 3

2.1 Identifying Opportunities for Collaboration..... 3

2.2 Drafting the Proposal Ideas and Overall Project Strategy..... 4

2.2.1 Drafting the proposal ideas..... 4

2.2.2 Shaping the Overall Project Strategy & Technical Approach..... 5

Annex: Industrial HRI Challenges..... 7

CH1. Dismantling and assembly of high-value products..... 7

CH2. Complex Product Picking in industrial warehouses..... 8

CH3. Flexible Collaborative robots..... 9

CH4. Smart Programming..... 10

CH5. Enhanced robot functionality through multimodal HRI..... 11

CH6. Fetch & carry tasks in healthcare environments..... 12

CH7. HRI for improved worker efficiency in high-precision flexible tasks..... 13

CH8. HRI for improving ergonomics in high precision tasks..... 14

Co-funded by the European Union

1 Introducing the ARISE Technical Framework

1.1 Purpose, objectives, and scope of the framework

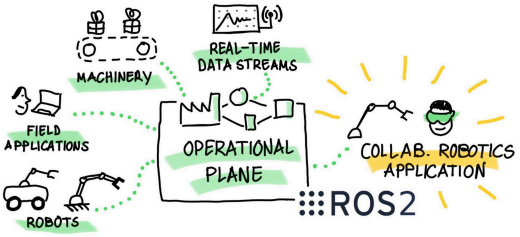
The primary goal of ARISE is to identify and accelerate real-world scenarios of collaborative robotics applications. Major objectives in these scenarios are to enhance human performance in challenging industrial tasks as well as to increase the inclusiveness and safety of industrial workplaces. The ARISE technical framework provides a suite of open-source enabling technologies, tools, and utilities which are carefully designed to help technology providers create innovative and cost-effective solutions for the industry.

1.2 Harmonized model for Developing Industrial HRI Applications

The ARISE technical framework builds upon PAL Robotics' approach to developing Robotics Applications, or "Robot Apps". These apps are designed to simplify the modularity, packaging, and auto-discovery of individual robot capabilities, facilitating their seamless integration into more advanced functionalities and complex behaviors. PAL robotics' documentation includes a dedicated section to guide application designers and developers through the process of designing, implementing, and working with these robot apps.

1.3 ARISE Middleware Technologies: ROS 2 and FIWARE

ROS 2: The Robot Operating System(ROS) is a set of software libraries and tools for building robot applications. From drivers and SotA algorithms to powerful developer tools, ROS has the toolbox you need for an open source based robotics project. Every ARISE experiment will deliver at least one ROS 2 app. Furthermore, all of them will leverage the same ROS 2 distribution, EPROSIMA's Vulcanexus. Vulcanexus offers a particular version of ROS 2 that targets i) optimal performance to operate in commercial products and ii) improved user experience by extending ROS 2 with complementary design & development tools.



The purpose of leveraging ROS 2 in every funded experiment ARISE is twofold:

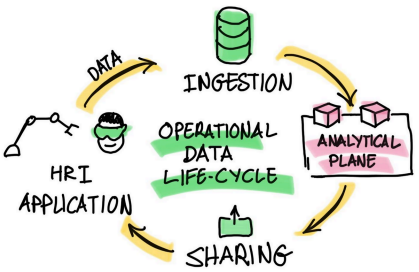
First, in each experiment, at least one of the robot apps included in the HRI module of the collaborative robotics application must be implemented using ROS 2 (e.g., a ROS 2 app which implements collaborative robot application for screwdriving operations). The goal is to ensure that i) every single funded experiment in ARISE contributes to a shared catalog with an open source based reusable module and ii) all the modules in the catalog export the same interfaces (e.g., ROS 2 topics, services, and actions).

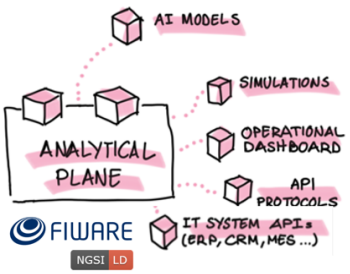
Second, ROS 2 is to be used in ARISE projects as a common open middleware for the experiments' operational data plane. This operational data plane may involve a series of machines, robots, cameras or sensors that are relevant to solve the problem addressed. Integrating their data brings the potential for other modules to enhance the overall performance of the collaborative robotics application or to generate valuable insights for operations and business units. Projects are encouraged to leverage ROS 2 as much as possible for this integration.

Co-funded by the European Union

FIWARE: FIWARE brings a curated framework of open source software platform components which can be assembled together and with other third-party components to build platforms that support the development of Smart Analytics Solutions faster, easier and cheaper.

In the context of ARISE, and in respect to this analytical data plane, the role of (data) platforms is a cornerstone enabler for i) the use, re-use, and continuum of the data life-cycle in the operational data plane and ii) for the technical convergence required between information and operation systems (IT/OT convergence). Without these features, it is impossible for a solution to generate an added value analytical data plane that builds not only on historical data and past situations but also on the data that is currently flowing in the shop floor through the operations data plane.



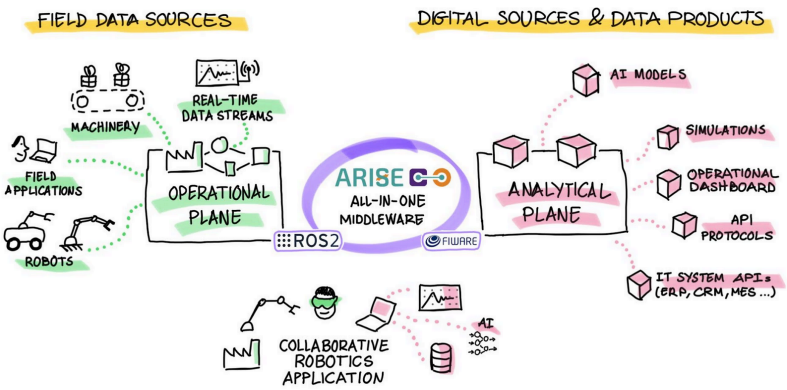


The purpose of leveraging FIWARE in ARISE is precisely to accelerate robotics and operation technology innovators when they face problems to integrate with innovative information technologies and enabling a seamless connection among the operational and analytical planes. ARISE aims to empower robotics innovators with the right open source tools to develop and demonstrate added value solutions which are ready to contribute to and benefit from real-time analytics, IIoT applications, and AI-powered services.

ARISE funded experiments will leverage FIWARE to implement a condition monitoring application which consists of i) a real-time data visualization dashboard, ii) a data historian with analytics dashboard and iii) a service for the automated generation of events, alerts, and reports.

1.4 ARISE's All-in-one Middleware for Industrial HRI in action

Along with the mentoring services offered from ARISE to funded experiments, the concept of All-in-one middleware captures the essence of what our Technical Framework brings in to accelerate the execution of ARISE funded experiments. ARISE has developed a version of Orion-ld, a powerful software component for efficient data brokering, which natively supports ROS 2 and FIWARE (NGSI-LD) interfaces. This allows applicants to decouple OT and IT problems and focus, on the one hand, on the creation of the ROS 2 based collaborative robotics application and operational data plane and on the other hand, they can focus on implementing a 'Powered by FIWARE' application which contributes with a series of IT services such as operational dashboards, data historians, AI/ML services, simulations, etc. ARISE will enable the seamless integration between these heterogeneous data sources and across operational and analytical data planes by following a straightforward configuration process for Orion-ld.



Co-funded by the European Union

2 Steps to prepare a competitive proposal

2.1 Identifying Opportunities for Collaboration

There is always an opportunity to prepare a proposal if an industrial end-user has clearly identified a need to improve the conditions of their workspace. The perfect complement to this need is a technology partner capable of envisioning a solution where a collaborative robotics application plays a key role. The most important thing is to make it clear from the beginning of the collaboration that the value of the idea depends closely on its focus on facilitating, accelerating, or enabling the worker(s) to achieve better performance. Solutions that merely aim to automate a task and move the worker to a different one are not the goal of the ARISE program.

An alternative situation is one where a technology company has the capabilities to develop and apply collaborative robotics in innovative industrial solutions. In this case, the company finds value in developing a reusable and replicable solution to expand its portfolio. However, it looks for and needs to identify a "client" whose requirements align with the solution the company aims to develop. The risk in these cases is that the project idea may feel artificial and somewhat forced to fit the ARISE program requirements. To avoid this, it's crucial that both the tech provider and the client work together to identify the added value of the potential project beyond the funding offered. Without finding this added value, the idea will be built on a fundamental weakness, making the eventual proposal unlikely to succeed.

Checklist:

- ☐ 1. Go to the Guide for applicants and read carefully “Section nº3 - Eligibility Criteria” and, in particular, “Subsection 3.1 - Who are we looking for?”. This is an essential step to ensure that you are building an admissible consortium.
- ☐ 2. Once you've confirmed that you form a valid consortium, take a moment to reflect on the potential limitations of your organizations in executing the project. For instance, the tech provider may lack certain development skills, or the end user may be unable to support a TRL6/7 demonstrator. The ARISE program recognizes that such limitations may exist and provides considerable flexibility in subcontracting to ensure that the project has the best possible team in place.
- ☐ 3. At this stage, it’s also a good idea to start considering WHICH of the challenges (see Annex) you will select as the focus of your project. While you may identify multiple challenges related to your idea, you will only be able to designate one challenge as the target at the end of the application process.

Next Step:

Now that a preliminary idea and a project team are in place, it’s time to draft the proposal. It is especially important that this step focuses on aligning the preliminary idea with the strategy and approach outlined by the ARISE program. The next section provides the necessary details on this aspect.

Co-funded by
the European Union

2.2 Drafting the Proposal Ideas

Problem definition: Deepening the understanding of the user need

Further detailing the end-user's need and clearly defining the main problem the project will address are essential steps for developing a more advanced concept note for the project and eventually drafting the initial version of the proposal.

- **End-user Stories:** Define the types of end-user(s) who will engage with the project (including their professions, skills, interests, etc.), contextualize them in the industrial task at hand, and outline their specific needs.
- **Problem Statement:** Clearly articulate the problem the users are facing in a concise and meaningful paragraph that anyone, no matter the background, can understand
- **Relevance to the ARISE Program:** Go beyond the problem definition to introduce how solving will eventually create value for the end-user company. Tie the identified user needs directly to a series of preliminary project's objectives, highlighting why the solution is necessary. Revisit the ARISE challenges and double-check which of them is the one that relates the most to your context.

Checklist:

- ☐ Now you have a clear problem definition that revolves around the specific needs of a group of end-users engaged in a relevant task within a real-world industrial context.
- ☐ You have a clearer vision of how solving the problem will create added value for the end-user company by enhancing, accelerating, or even enabling safer and more productive performance for the identified end-user roles.

Defining the Project Mission and Ambition

State the long-term vision and aspirations for the project. Consider the ideal scenario that would represent complete success, achieved through the perfect solution to the identified problem. Pay particular attention to the following aspects:

- **Mission Statement:** Develop a mission statement that clearly defines the primary goal of the project and how it addresses user needs. This should reflect a digital transformation journey that focuses on how a human-centric solution which leverages robotics technology will help end-users achieve their objectives.
- **Objectives & Outcomes:** Compile a preliminary list of specific, measurable objectives that the project aims to achieve on its journey to fulfill its mission and ultimately realize the target vision. Additionally, draft a preliminary list of benefits associated with the achievement of each objective.
- **Ambition:** Gather relevant information not only on user behavior, preferences, and pain points related to the task at hand but also on state-of-the-art (SotA) approaches that have been proven successful in solving similar problems. Identify any needs or requirements that will necessitate going beyond the state of the art (SotA) to find a solution for this particular project. Take it a step further and frame this as an overarching ambition for the project.

Checklist

- ☐ You have a clear definition of the project's main goal, broken down into a series of objectives, along with a solid understanding of their associated added value.
- ☐ You have identified existing approaches and solutions that define the SotA for the context of our project. You clearly understand and feel confident explaining why your project is ambitious and needs to go beyond the current SotA.

Co-funded by the European Union

2.3 Shaping the Overall Project Strategy & Technical Approach

You have already defined a core project idea which is relevant to the ARISE program and mission statement, an overall ambition, and a series of clear objectives. The next steps involve developing a suitable strategy and technical approach which demonstrates alignment and commitment to the requirements of the ARISE program. However, the commitment of the ARISE program with the European Commision goes beyond merely identifying and showcase relevant project ideas. It seeks to support projects that help validate an additional hypothesis: that it is possible to accelerate innovation in industrial Human-Robot Interaction (HRI) through the use of open-source technologies. Specifically, ARISE aims to demonstrate that:

- ROS 2, particularly its Vulcanexus distribution, provides a suitable middleware and toolset for developing reusable "apps" or modules that can speed up the creation of innovative robotic applications.
- ROS 2, especially its Vulcanexus distribution, offers a middleware that facilitates the implementation of distributed collaborative robotics applications. In these applications, the apps or modules do not run embedded within a single integrated robotic platform. Instead, there may be multiple robotic platforms, sensors, cameras, and actuators working together in a collaborative application, with ROS 2 enabling seamless interaction among all of them.
- FIWARE, as the reference provider of open standards (NGSI-LD) and open source technologies for context information management offers a middleware that facilitates the implementation of added value analytical planes on top of the shop floor's operational data. Building an analytical plane is a cornerstone to implement condition monitoring, smart analytics, and predictive maintenance applications. It is also a cornerstone to integrate with advanced simulators, AI powered services and well-known industrial IT systems (e.g., MES, ERP, WMS, CRM).

- Finally, ARISE is committed to demonstrate that ROS 2 and FIWARE, when combined in a single technology stack, and offered to industrial HRI innovators as an off-the-shelf and full stack middleware tool can boost European innovation in the domain of collaborative robotics applications for the industry.

That said, ARISE does not intend for technology providers to abandon their preferred technologies in favor of the ARISE technology stack. On the contrary, the proposed solution can and should build upon the technologies with which the provider is already comfortable. The key focus is that the project proposal should outline a strategy which considers ROS 2 and FIWARE as enablers, accelerators, and guarantors of reusability for the innovative modules that will be built around those existing technologies.

It is essential to adopt agile models and continuous improvement practices, with concrete objectives aimed at achieving small and meaningful progress in each iteration. A successful proposal will clearly define a concept for a proof-of-concept (PoC) of the project idea, considering that a demonstrator of this PoC must be delivered by the fourth month of the project. Additionally, the proposal should provide a vision and preliminary ideas on how this demonstrator will evolve to a TRL 6/7, keeping in mind that the final demonstrator, along with the necessary experimentation, is expected to be delivered by the project's Month 10.

Co-funded by
the European Union

Checklist

- ☐ You do have a preliminary idea on how to combine a ROS 2 based innovative module with your preferred technology stack.
- ☐ You already have in mind that either the entire module or part of it shall be packed and contributed as an open and reusable ROS 2 app to the ARISE catalog of robot apps for industrial collaborative robotics application development
- ☐ You have a clear understanding around the openness of the reusable ROS 2 app. You will contribute an open reference implementation of the app, which is fully functional and allows potential users to have a "test before invest experience". Premium features or embedded algorithms which are considered part of your IP could be removed or replaced by community versions in the open reference implementation contributed to the catalog.
- ☐ You do have a preliminary idea on how a Powered by FIWARE condition monitoring application can bring added value into the solution demonstrators. Mandatory features of the target condition monitoring application includes i) real-time data visualizations, data historians and smart analytics visualizations, and iii) automated generation of events, alerts, and task reports. How to implement the application could be a black box at this stage but at least the overall concept and value proposition for the condition monitoring application shall be in place.
- ☐ You do have a preliminary concept for the scope of two demonstrators PoC and TRL6/7
- ☐ [Bonus] You are able to envision an advanced use case for the All-in-one middleware. That is, you can envision a solution in which i) intensive use of ROS 2 is made beyond the contributed ROS 2 module and ii) the Powered by FIWARE condition monitoring application is extended with additional use cases such as distributed simulations, integration with AI powered features and/or enhanced interoperability with heterogeneous API protocols and/or industrial IT systems (e.g., MES, ERP, WMS…). By successfully addressing this aspect, the scoring of the proposal can turn from very good to EXCELLENT in the excellence section.

Co-funded by
the European Union

Annex: Industrial HRI Challenges

CH1. Dismantling and assembly of high-value products

Challenge Description: The challenge focuses on developing a collaborative Human-Robot Interaction (HRI) solution for dismantling and assembling high-value products. The goal is to automate tasks, enhance efficiency, reduce risks associated with hazardous materials and ensure worker safety, ultimately improving overall productivity. Key actors include collaborative robots, human workers, acoustic and luminous response devices, cameras and computer systems.

Inspiring Project Idea:

In a battery disassembly process, human workers supervise and make critical decisions, while a PC system calculates coordinates and coordinates robot actions. A dimensional camera captures images, and MR HoloLens glasses provide real-time visual information. The collaborative robot performs physical actions, such as selecting screws for disassembly, enhancing the efficiency and safety of the process. This integrated approach ensures a streamlined and effective disassembly process while maintaining high safety standards for human workers.

Guidelines on Collaborative Robotics Application Requirements

Collaborative robotics applications shall be tailored for the dismantling and assembly of high-value products. The system should enhance automation, efficiency, and safety while mitigating risks associated with hazardous materials. Prioritizing seamless human-robot collaboration, reducing manual handling of complex tasks, and incorporating safety protocols that protect human workers during interaction with robotic systems.

Going beyond the State-of-the-art

The challenge looks for innovative enablers of industrial HRI capabilities in multiple areas, including **real-time 3D object perception** to localize objects accurately, **mixed reality** integration for enhanced situational awareness, robust **voice command recognition** for effective interaction and **efficient robot coordination** to guide actions in real-time. The solution should also consider **data protection** and **privacy principles**, ensuring **ethical handling of human-related data.**

Demonstrators (PoC and TRL6/7)

Demonstrators should provide a clear, measurable baseline for evaluating the solution's effectiveness, including metrics such as timing, workload, accuracy, and safety improvements. Convenient performance metrics must highlight the demonstrator's capacity to improve productivity, reduce human error, and enhance operational safety through the integrated HRI solutions. Trackable KPIs should include cycle time reductions, error rates, and increased operator safety.

Co-funded by the European Union

CH2. Complex Product Picking in industrial warehouses

Challenge Story/ Description: This challenge involves developing an HRI solution for product picking in industrial warehouses, specifically addressing tasks with complex products. The goal is to enhance the efficiency and accuracy of picking operations, reduce manual labor and improve the handling of delicate products. The system aims to enable seamless collaboration between robots and human workers, ensuring worker safety while maximizing efficiency. The solution must adapt to the high variability in shapes and weights of products and integrate with IT systems for handling purchase orders.

Inspiring Project Idea

In the example of fruit picking, human workers supervise operations using MR HoloLens glasses, which provide real-time visual feedback and instructions. A collaborative robot, guided by data from a camera and instructions from the MR glasses, performs the actual picking tasks. The system relies on seamless communication between the MR glasses, PC, robot and camera to ensure smooth and efficient operation. Key robotic critical functions include real-time 3D object localization, user interaction via voice commands and gestures, cognitive assistance for decision-making and optimization of the robot's trajectory to enhance task execution efficiency while maintaining high ethics and safety standards.

Guidelines on Collaborative Robotics Application Requirements

Collaborative Robotics Applications should develop HRI based solutions for product picking in industrial warehouses, particularly addressing the complexities of handling various products. The goal is to enhance the efficiency and accuracy of picking operations, reduce manual labor, and improve the handling of delicate and diverse items. The system aims to enable seamless collaboration between robots and human workers, ensuring worker safety while maximizing operational efficiency. It must adapt to the high variability in shapes, sizes, and weights of products and interact with existing IT systems for processing purchase orders.

Going beyond the State-of-the-art

The challenge looks for innovative enablers of industrial HRI capabilities in multiple areas, including advanced **object recognition and classification** to accurately identify and differentiate various products. Realtime data processing and **decision-making capabilities** are essential to adapt to dynamic warehouse conditions. Integration with warehouse management systems is crucial for **coordinating picking tasks** and optimizing workflow. Additionally, the system should provide **intuitive user interfaces** and feedback mechanisms to facilitate human-robot collaboration and ensure effective communication.

Demonstrators (PoC and TRL6/7)

Demonstrators should provide a clear, measurable baseline for evaluating the solution's effectiveness, including metrics such as timing, workload, accuracy, and safety improvements. Convenient performance metrics must highlight the demonstrator's capacity to improve productivity, reduce human error, and enhance operational safety through the integrated HRI solutions. Trackable KPIs should include cycle time reductions, error rates, and increased operator safety.

Co-funded by the European Union

CH3. Flexible Collaborative robots

Story/ Description: The challenge involves developing advanced HRI solutions to support operators, reducing production cycle time, increasing quality and improving working conditions in agile work environments. Manufacturing companies need flexible solutions to meet varying demands, requiring both versatile hardware (e.g., adaptable grippers) and adaptable software (e.g., behavior flexibility and hardware independence). The goal is to achieve a reprogrammable robotics workstation that adapts to variable production requirements, ensuring plug-and-play modularity for both hardware and software components.

Inspiring Project Idea

Assembly and packing robotic assistant in which a collaborative robot aids the operator by providing components and performing fine manual operations, such as sorting heavy products into trays. The operator supervises the robot's activity, manages the packing area, and handles exceptions. The robot recognizes objects, picks them up and places them in trays based on pre-programmed sequences. Critical functions include force operations, fine manual operations and real-time communication between the operator and robot. Systems must ensure safety, adaptability and efficient collaboration to optimize production processes.

Guidelines on Collaborative Robotics Application Requirements

The applications should consist of a flexible and reprogrammable workstation, where the robot should recognize and manage heavy or complex products, safeguarding the operator from injuries and safety problems, while the operator should monitor the robot's activity and intervene, for example, if requested by the task, if inaccuracies occur or unexpected forces are requested to perform the task ensuring human-robot collaboration.

Going beyond the State-of-the-art

Target innovations include the integration with company management systems to access product information, **object recognition and localization** to accurately identify and handle objects, and **tray recognition** to manage specific constraints. The system must support precise **picking and placing operations**, human-robot **collaboration where operators can intervene in robot tasks** and **user-friendly interfaces** like HMIs or voice command systems. **Real-time posture monitoring** is also essential to ensure ergonomic safety for operators.

Demonstrators (PoC and TRL6/7)

Demonstrators should provide a clear, measurable baseline for evaluating the solution's effectiveness and scalability, including metrics such as timing, workload, accuracy, human involvement and safety improvements. They should address a real-world context where the HRI module and ARISE technologies have to be involved and exploited in order to have a positive impact on the industrial use case. The positive impact has to be measured (KPI) or highlighted in terms of productivity, effectiveness, operator safety improvements and process digitalization.

Co-funded by
the European Union

CH4. Smart Programming

Challenge Story/ Description: The challenge focuses on developing a robotics workstation that enables workers without programming skills to easily reprogram it for highly variable production needs. The system aims to provide intuitive interfaces and AI algorithms to ensure flexibility and ease of use, allowing operators to adapt the workstation's behavior without extensive coding knowledge. This approach enhances adaptability to different products while preserving operators' autonomy in agile manufacturing environments.

Inspiring Project Idea

Robotic kitting assistant, which the system enables operators to assemble kits by selecting products from the company's management system. The robot retrieves a list of objects, their locations and picks from an automated warehouse while the operator can pick items from the classic shelves and updates the list as items are picked. The robot navigates autonomously or in follow-me mode, picking items from shelves or automated warehouses and placing them into the assembly kit bin. Critical functions include company system integration, automated warehouse interface, operator interface for list management and navigation capabilities for the robot. The system ensures accurate inventory tracking, quality checks and operator safety while promoting collaboration between humans and robots in the kitting process.

Guidelines on Collaborative Robotics Application Requirements

Applications consist of a smart programmed robotics assistant for repetitive and physically demanding tasks. The robot should be programmed by the operator naturally through intuitive interfaces (hand guidance, voice, motion capture systems) and be able to manipulate items without or with few examples. The operator collaborates with the robot both in the programming phase and in the task execution phase syncing their progress.

Going beyond the State-of-the-art

Innovations include the **integration with company management systems** to access product information, intuitive **interfaces for operators to update programming easily** and **AI algorithms for behavior adaptiveness**. The system must support **natural language and gesture recognition** for intuitive interactions, as well as the **adaptation of robot behavior to optimize workers' ergonomics**. Previous programming should be stored for potential reuse, and the system should ensure **flexibility and adaptability to production variations**.

Demonstrators (PoC and TRL6/7)

Demonstrators should provide a clear, measurable baseline for evaluating the solution’s effectiveness and scalability, including metrics such as timing, workload, accuracy, human involvement and safety improvements. They should address a real-world context where the HRI module and ARISE technologies have to be involved and exploited in order to have a positive impact on the industrial use case. The positive impact has to be measured (KPI) or highlighted in terms of productivity, effectiveness, operator safety improvements and process digitalization.

Co-funded by
the European Union

CH5. Enhanced robot functionality through multimodal HRI

Challenge Story/Description: aims to revolutionize human-robot interactions by leveraging advanced multimodal communication methods, including verbal cues, gestures and visual feedback. The goal is to enhance collaboration between non-roboticist/non-expert users and robots, particularly in assisted living contexts. The challenge addresses various aspects such as better detection of user engagement/disengagement, robust speech recognition and the integration of rich dialogue with user profiles.

Inspiring Project Idea

A guided stretching session with an interactive robot which enables personalized interactions between the robot and patients. The robot assesses the user's needs, guides them through exercises using multimodal communication and adapts the session based on the user's progress and feedback. Critical functions include speech recognition, activity recognition, user profile storage, facial expression recognition and adaptive learning algorithms. The system ensures a human-centric approach to assisted living tasks, empowering users and providing personalized care experiences.

Guidelines on Collaborative Robotics Application Requirements

Applications addressing this challenge aim to transform human-robot interactions by utilizing advanced multimodal communication methods, including verbal cues, gestures, and visual feedback. The primary goal is to enhance collaboration between robots and non-expert users, particularly in assisted living contexts, where intuitive interaction is essential. The challenge addresses several key aspects, such as improved detection of user engagement/disengagement, robust speech recognition, and the integration of rich dialogue systems with personalized user profiles.

Going beyond the State-of-the-art

The system must possess several key capabilities to meet the challenge requirements. These include **advanced speech recognition** and **natural language processing** for seamless communication, user profile representation and storage for personalization, **activity recognition** for understanding user behavior and **facial expression/emotion recognition** for enhanced interaction. Additionally, the system should employ **adaptive learning algorithms** to improve performance over time and support **multimodal communication** for effective interaction.

Demonstrators

Demonstrators should provide a clear, measurable baseline for evaluating the solution's effectiveness and scalability, including metrics such as timing, workload, accuracy, human involvement and safety improvements. They should address a real-world context where the HRI module and ARISE technologies have to be involved and exploited in order to have a positive impact on the industrial use case. The positive impact has to be measured (KPI) or highlighted in terms of productivity, effectiveness, operator safety improvements and process digitalization.

Co-funded by the European Union

CH6. Fetch & carry tasks in healthcare environments

Challenge Story/Description: focuses on developing and implementing robotic systems capable of autonomously performing fetch and carry tasks within healthcare settings. By automating these routine tasks, the goal is to alleviate the workload of medical staff, allowing them to concentrate on direct patient care and other critical responsibilities. Key objectives include improving the reliability of mobile manipulators, developing robust interaction flows, building trust among end-users and creating a safe social navigation system.

Inspiring Project Idea

Asking for help while carrying medical samples, the system enables seamless interactions between hospital staff and mobile manipulators like PAL TIAGo. The robot autonomously navigates through the hospital environment, receives medical samples from staff members, and transports them to designated locations such as laboratories. Critical functions include social navigation to navigate around humans, speech recognition to understand voice commands and activity recognition to react appropriately based on detected human activities. The system ensures efficient and safe sample transportation, contributing to improved workflow and patient care in healthcare environments.

Guidelines on Collaborative Robotics Application Requirements

Applications addressing this challenge aim to develop and implement robotic systems capable of autonomously performing fetch and carry tasks in healthcare settings. By automating these routine tasks, the goal is to reduce the workload on medical staff, allowing them to focus more on direct patient care and other critical responsibilities. Key objectives include enhancing the reliability of mobile manipulators, creating robust interaction flows, building trust among end-users, and establishing a safe and effective social navigation system within complex hospital environments.

Going beyond the State-of-the-art

To perform in this challenge, robotics systems must possess several critical capabilities, including **social navigation** to navigate around humans **in complex environments**, navigation for social approaches when the robot needs to **interact closely with humans**, activity and group recognition for **understanding human behaviour**, **speech recognition and natural language processing** for seamless communication, **people recognition** for detecting humans and **multimodal communication** for effective interaction.

Demonstrators

Demonstrators should provide a clear, measurable baseline for evaluating the solution's effectiveness and scalability, including metrics such as timing, workload, accuracy, human involvement and safety improvements. They should address a real-world context where the HRI module and ARISE technologies have to be involved and exploited in order to have a positive impact on the industrial use case. The positive impact has to be measured (KPI) or highlighted in terms of productivity, effectiveness, operator safety improvements and process digitalization.

Co-funded by the European Union

CH7. HRI for improved worker efficiency in high-precision flexible tasks

Challenge/Description: focuses on deploying Human-Robot Interaction (HRI) to enhance the efficiency of workers engaged in high-precision flexible tasks within manufacturing environments. These tasks often involve intricate processes and significant setup times, particularly in scenarios where zero-defect manufacturing standards must be met. By leveraging robotics, the aim is to streamline the workspace setup process, thereby reducing overall setup time and improving operational efficiency.

Inspiring Project Idea

PCB desoldering which system employs a collaborative robot to assist operators in reworking defective printed circuit boards (PCBs). The cobot autonomously prepares the workspace for operators by selecting and placing the necessary tools and functional components based on information extracted from the quality control check. This process involves real-time 3D object detection to identify tools and components, robotic arm trajectory planning to execute precise movements and mobile robot navigation for seamless transportation of PCBs. By offloading tasks such as tool selection and workspace setup to the cobot, operators can focus more on the meticulous task of soldering/desoldering, thereby enhancing overall efficiency and reducing physical and mental stress.

Guidelines on Collaborative Robotics Application Requirements

The application should match the standards for the exploitation of collaborative robots with the aim of enhancing worker's efficiency. This exploitation can be either a human-robot interaction or human-robot collaboration with the aim of addressing the challenges stemming from high precision requirements of the manufacturing tasks. Leveraging on cobots to address high precision tasks might be done based on (not limited to):

- High precision end-effectors
- Vision system integration
- Programming for task-specific precision
- Force and compliance control
- Safe human-robot interaction
- Environmental control and cleanliness

Going beyond the State-of-the-art

To address this challenge effectively, the system might benefit from **vision systems to support the operator** in **enhancing precision and accuracy**, enabling **real-time quality Inspection**, assisting with **complex assembly** tasks, and supporting **safety and compliance**. Along with advancing technical features, considerations for data protection and privacy, as well as the long-term implications of technology adoption, are essential parts of the system.

Demonstrators

It is necessary to present a quantifiable baseline to assess the effectiveness of the presented solution for metrics such as data latency, human workload,collaborative robot involvement, error rates, and safety risks mitigations. Performance metrics must highlight the demonstrator's capacity to improve productivity, reduce human error, and enhance operational safety through the integrated HRI solutions. Trackable KPIs should include cycle time reductions, error rates, and increased operator safety.Trackable KPIs should include cycle process time, error rates, and increased average manufacturing time reduction.

Co-funded by the European Union

CH8. HRI for improving ergonomics in high precision tasks

Challenge/Description: seeks to enhance human ergonomics and comfort during high-precision tasks through the deployment of Human-Robot Interaction (HRI) systems. Many precision manual tasks involve working with delicate objects and require dedicated fixed frames for proper positioning, leading to setup times that detract from operators' primary activities. Inappropriate adjustments of these frames can lead to long-term health issues. This challenge focuses on the design of a set up considering the human physical properties in order to respect operator's ergonomics and well-being.

Inspiring Project Idea

A workpiece holder where a cobot adjusts the position and orientation of a workpiece based on the physical characteristics of the operator. Using machine vision, the system analyzes the operator's height and neck length to determine the optimal position and orientation for the workpiece. Additionally, operators can verbally command the cobot to make further adjustments for comfort. This solution offers advantages over conventional methods by providing a wider range of adjustability and more intuitive interaction with the robot. Critical functions include speech command detection for understanding operator instructions, ergonomics and comfort recognition for precise positioning, and stress recognition for ensuring operator well-being. Overall, the system enhances ergonomics and comfort during high-precision tasks, contributing to improved operator health and efficiency.

Guidelines on Collaborative Robotics Application Requirements

Applications addressing this challenge must meet the criteria for mitigating human operator long-term health risk issues by integrating Cobots into manufacturing operations. The provided system should effectively collaborate with human operators, and result in a more comfortable, ergonomic and safer working environment.

Going beyond the State-of-the-art

To address the challenge, the application may employ cobots together with other devices to implement advanced enabling capabilities to address one or more of the following scenarios:

- **Reduction of repetitive and strain-intensive tasks**
- **Operator's mental and physical work-load balancing**
- **Improved posture** and **work positioning**
- **Enhanced precision** with **reduced human physical effort**
- **Mitigating cognitive load and stress**
- **Flexible workspaces** and **customizable task support**

The system set up should be capable of effectively interacting with the operator to receive feedback regarding his comfort and further needs or potential desires.

Demonstrators

It is required to present a quantifiable baseline to assess the significance of the presented solution for metrics such as data latency, human workload, related human factors such as fatigue, stress, etc. , and safety and ergonomics improvements. It is a cornerstone to highlight the demonstrator's ability to improve productivity, reduce human error, and enhance operational safety through the integrated HRI solutions. Trackable KPIs should include cycle time reductions, error rates, and increased operator safety.

Co-funded by
the European Union