MASTER

Annex 4

MASTER 2nd Open Call

April 2025

Submission of applications starts on the 7th of April 2025, at 09:00 (CET)

Submission deadline: The 12th of June 2025, at 18:00 (CET)

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1 Annex 4: Educational Challenges definition

This document defines the educational challenges for the second Open Call (OC2) of the MASTER project. The challenges are categorized into three main areas: **Industrial Applications, Get to Know the Robots, and Open Challenge – Innovative Applications on Training of Industrial Robotics**. Each challenge aims to enhance robotics education through XR technologies by providing structured learning experiences and validating technologies developed in OC1. Participants are encouraged to develop interactive and impactful solutions that address real-world training needs in robotics and manufacturing under each challenge.

1.1 Industrial applications

This pillar gathers the challenges for creating XR-based educational experiences that enhance industrial robotics training by simulating real-world manufacturing processes.

1.1.1 EC – 1: "Creation of machine tending applications"

Develop an XR training module that teaches operators how to program and manage robotic machine tending tasks. This includes robot movements as well as pick and place operations, while a synchronization of the robot with an external machine, in this case a tending machine, would be an extra element for the training scenario The solution should focus on automation workflows to synchronize the different machines and processes, safety procedures to ensure human safety, and optimizing robot efficiency in manufacturing environments.

1.1.2 EC – 2: "Creation of line following robot applications"

Design an XR-based learning tool that allows students to explore and simulate how robots follow predefined paths for tasks like welding, painting, or grinding. This should also include sensors that enable the robots recognize contours, lines or any other pattern that should be followed to perform their movement. The application should provide interactive lessons on robot programming, sensor integration for precision-based operations and testing of the final application.

1.1.3 EC – 3: "Robot-assisted quality inspection"

Create an XR educational scenario that teaches how robots and perception devices can be used for quality control in industrial environments. The module should focus on how a robot can be equipped with robotic vision systems to perform defect detection and AI-driven inspection techniques on different parts or products. Such operations are very important and are widely used in several industries such as automotive, white goods, consumer goods industry etc.

1.1.4 EC – 4: "XR for collaborative robot programming"

Collaborative robots (cobots) are a key player in Industry 5.0 applications. Thus, training the new workforce on such technologies is crucial. Under this challenge it is expected to develop an XR-based training program that introduces users to the programming of cobots. The solution should emphasize the differences of a cobot compared to a typical industrial one as well as to peripheral modules such as safety modules, real-time human-robot interaction mechanisms, and intuitive programming interfaces for non-experts.

1.2 Get to Know the Robots

This pillar gathers the challenges that aim to provide fundamental knowledge on robotic systems themselves such as programming and maintaining the robot as well devices that are integrated to it such as safety machines, making it more accessible to students and professionals.

1.2.1 EC – 5: "Understanding the robot references systems"

One of the basics on how robots work are the reference systems based on which the kinematic chain is built. Thus, designing an XR learning module that explains robot coordinate systems, reference frames, and transformations is a crucial first step to understand how robots behave. This will help learners understand how robots navigate, interact with their surroundings and how programming multiple movements with different reference systems is possible.

1.2.2 EC – 6: "Develop educational material focused on HRC for the general public"

The human operator plays a vital role in the industrial environment and the robotic applications. Thus, this challenge is focused on Human Robot Collaboration activities. This challenge focuses on creating engaging educational content that introduces Human-Robot Collaboration to a broad audience. The material should highlight real-world applications, ethical considerations, and the role of both human and robots in modern industries.

1.2.3 EC – 7: "Simulating robotic maintenance procedures"

A key responsibility, especially for the technical personnel, is to ensure the proper running of all the robotic machines and their peripherals. This educational challenge addresses this exact issue, by developing an XR-based education scenario for training on robotic maintenance, diagnostics, and troubleshooting. Additionally, the solution should focus on preventive maintenance techniques, identifying common failures, and safety protocols.

1.2.4 EC – 8: "Safety in human-robot collaboration"

This educational challenge focuses on safety aspects of human operators in the workplaces, namely use of safety sensors, safety protocols, ergonomic postures etc. Thus, the education scenarios under this challenge should aim for an interactive XR module that teaches best practices for ensuring safety in collaborative robotics environments. The training should focus on risk assessment, emergency handling, compliance with safety regulations, ergonomic best practices etc.

1.3 Open Challenge – Innovative applications on training of industrial robotics

The last pillar gathers the challenges that aim to encourage applicants to propose novel solutions that push the boundaries of XR-based robotics education by creating innovative applications more openly, beyond the scope of the two previous pillars.

1.3.1 EC – 9: "Introduction of AI on training of industrial robotics"

With the growth of AI technology and especially generative-AI with the introduction of LLMs, this challenge invites the applicants to explore how AI can be integrated into XR-based robotics training. This could include intelligent tutoring systems, AI-assisted troubleshooting, or adaptive learning based on user performance. This open challenge can be addressed by an education scenario where industrial robotics and AI have the leading role.

1.3.2 EC – 10: “XR for remote and inclusive robotics education”

XR technologies is a key enabler for people with disabilities to be emerged in a world adapted to their needs, including training on robotic technologies. Under this educational challenge, the aim is to develop an XR-based solution that makes robotics education more accessible to remote learners and/or individuals with disabilities. The challenge encourages features like voice control, adaptive interfaces and materials, capabilities for people with hearing impairments as well as foster remote team creation through cloud-based collaboration.

1.3.3 EC – 11: “Multimodal interaction for XR-based robotics training”

XR technology is about interacting with the digital modes using multiple methods to make the experience more immersive. This challenge is looking for education scenarios that investigate how combining multiple interaction modalities such as voice, gesture, gaze, haptics etc. can enhance XR-based robotics education. This challenge aims to create intuitive and immersive training experiences for the operators, independently of the robotic scenario they will perform.

1.3.4 EC – 12: “Gamification of robotics training in XR”

It is commonly said that XR has great potential in the education due to its gamification characteristics. Thus, in this educational challenge, designing a gamified learning experience that uses XR to improve engagement and retention in robotics training is the key target. This could include leaderboards, challenges, and interactive missions that teach programming and robotic skills in a fun and engaging way.

1.4 Conclusion

This document serves as a guideline for applicants to develop innovative XR-based educational solutions that address key educational challenges in industrial robotics training. Applications should aim to provide scalable, interactive, and impactful learning experiences that should be validated by teams of students from the education institute that will create them. Ideally the education institutes should aim for different types of stakeholders, namely robot operators, technicians, engineers or young students, targeting the most suitable type in each challenge depending on its requirements.