MASTER

Annex 4

MASTER 1st Open Call

March 2024

Submission of applications starts on 18th of March 2024, at 09:00 (CET)

Submission deadline: 31st of May 2024, at 17:00 (CET)

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1 Annex 4: Technical Challenges definition

1.1 Safety and ergonomy in workplace

Efficient HRI requires the creation of a safe environment for the operator. The general approach of achieving this is to exploit latest advances of XR technologies. The technologies applied under this group of challenges should enable the creation of safe workplaces and help the trainees to learn how production operations should be performed in a safe way.

1.1.1 TC – 1: "Integrating machine learning methods to XR tools towards accurate layout planning and validation"

The first technical challenge is focused on the use and integration of AI-based methods that can be leveraged in a XR environment for generating and validating new layouts required for the safety-related education scenarios. More specifically, with the advancement of AI-based tools, it is possible to offer tools to the content creators that would enable them not only to avoid writing any code, but also to avoid the use of approaches such as "drag and drop" and parameterization of already-made models. Thus, using simple inputs such as text-prompts, sketches or any other intuitive input that can be understood by an AI-based platform and generate content in the XR environment. Additionally, the AI-based methods can be used to validate layouts created by the content creators who want to learn how to design operator-friendly layouts and/or production plans, based on the resources they have at their disposal. In conclusion, the target of this challenge is to gather applications able to provide AI-based technologies to create new content, paving new roads in the XR-content creation, avoiding traditional methods of scene generation.

1.1.2 TC – 2: "XR-based environment for ergonomics training methods to evaluate and best-practices suggestion"

An important aspect in human safety is the ergonomy of the operators. Training them how they can perform their operations with the minimum possible stress, both on mental and physical level, plays an important role in their well-being and productivity. For this reason, the operators should be educated on the potential dangers that may occur during the different processes and train them how to avoid them, suggesting best practices. Under this challenge, the inclusion of AI-based libraries could also be considered but it is not mandatory. The key focus is on the ergonomic aspects, thus the main target is the provision of libraries that would help the content creators design XR-based environment in which the operators can be trained on how to perform in an ergonomic way and stress-free the necessary operations.

1.1.3 TC – 3: "Real-time visualization of safety-related information in XR environment to increase operators' safety awareness"

The third technical challenge is focused on increasing operator's awareness on safety-related aspects when working in a dynamic environment, such as the manufacturing. This can include the provision of warning messages, information related to the robots or other machines, digital shadows of moving objects before the real ones actually move, confirmation menus asking for permission from the operators before a predefined operation takes place etc. Under this challenge the applicants should offer the necessary tools so the content creators can create dynamic scenarios that can address the above and help the operators feel safe in an automated environment, since they will be aware for any activity that would take place or even allow it to starts when they are ready. Similar to the above, AI-

based tools can be proposed to give a better flexibility to the content creators, but they are not the key focus of the challenge.

1.1.4 TC – 4: "Open challenge related to improved working conditions in the workplace"

The last technical challenge is open, giving the applicants the flexibility to provide any XR-related technology that can contribute to the creation of education material focused on the safety and ergonomy of the human operators in the manufacturing domain. Of course, it can combine functionalities covering more than one of the above challenges, or it is targeted to other challenges, completely different from the above, but within the safety and ergonomics in workplace scope.

1.2 Intuitive robot programming

One of the challenges for working with robots is to be able to program them. Programming by coding is hard for most. Instead, we want to exploit the capabilities that XR technologies offer to provide intuitive techniques to teach new skills to robots, with program code being generated automatically in the background.

1.2.1 TC – 5: "XR-based system to program on demand tasks to stationary robots"

In industrial automation, the ability to quickly adapt production processes to new product specifications is a key competitive advantage. Robots offer the flexibility to adapt production processes frequently to adapt to production customisation requirements. However, programming robots must be an easy and intuitive task for production workers.

The target of this challenge is to create a system based on XR technologies that allows users (students, trainees, or production workers) to program new tasks for stationary robots to execute. The system should be useful for the programming of a range of tasks, from simple repetitive actions to more complex sequences. The solution should emphasize ease of use, flexibility, and precision, allowing for quick reconfiguration of robotic tasks in response to changing production needs. Considering this, the solution to this challenge will be in the form of libraries that help content creators design XR-based environments for the programming of stationary robots.

1.2.2 TC – 6: "XR-based programming of mobile robots for intralogistics operations"

Mobile robots are widely used for intralogistics operations. The objective of this challenge is to create a virtual learning environment (a simulated warehouse or factory setting) where students can learn to program and manage mobile robots. Applicants to this challenge will provide content creators with flexible XR tools to simulate such environments and generate learning experiences illustrating how mobile robots should be programmed and managed in common intralogistics operations. The XR tools will support creating contents that provide instruction on how to interact with holographic digital twins of mobile robots, learning to program them for tasks such as material transport, inventory management, and navigation through complex environments.

1.2.3 TC – 7: "Intuitive XR-based robot programming for assembly and packaging tasks"

Applicants to this challenge will provide XR tools for content creators to produce an immersive learning environment where students can interact with virtual representations of robots, programming them to execute assembly sequences and efficient packaging operations, with a focus on precision and efficiency. The tools will provide support for programming common assembly tasks, such as tedious repetitive tasks and tasks requiring high precision and dexterity. Support for programming packaging operations will include wrapping, sealing, labelling, and preparing goods for distribution. In packaging operations, created contents will help develop awareness about the importance of precision and correctness regarding orientation and placement of components and materials involved in the process.

1.2.4 TC – 8: "Any challenge related to Intuitive robot programming of manufacturing operations"

In this more open technical challenge, applicants will have the flexibility to propose XR tools to create contents to learn robot programming for manufacturing operations relevant in many industrial production processes. Examples include (but are not limited to) robot manufacturing tasks such as machine tending, machining, inspection, repairing etc. The tools developed will support showcasing the challenges that workers encounter when programming robots for such tasks in real world scenarios and it will introduce problem solving strategies to achieve optimum results from the points of view of quality in manufacturing, efficiency of the process and task sharing between robot and human worker.

1.3 User-friendly HRI methods

Human-robot interaction should be designed well to support users effectively and efficiently in their tasks. XR technology can help by augmenting scenes with otherwise invisible information, but also comes with its own challenges. We aim to address the challenges in creating interfaces with a high usability and a good user experience.

1.3.1 TC – 9: "Interaction systems in multi-player virtual environments"

The ninth technical challenge focusses on collaborative interaction settings in mixed-reality environments. Applicants are encouraged to propose solutions that make collaboration more effective and efficient. Examples include the development of group-centric interaction designs and prototypes that explicitly organize group-work in XR or implicit sensor-based cues that help collaborators to understand intentions of their co-workers, e.g., by visualizing where a speaker looks when explaining a complex topic.

1.3.2 TC – 10: "Advanced multi-modal (i.e. voice, gesture, gaze) interaction system"

HRI can benefit from multimodal-multisensor interaction technologies that combine one or more input modalities with sensor information. For instance, additional input modalities enable users to flexibly choose how to interact with a system based on their preference or the interaction context, sensor information can disambiguate otherwise ambiguous inputs, and multiple input modalities can be fused to enable more robust HRI. We welcome applications that implement multimodal-multisensor interaction technologies including, e.g., voice, gestures, and human gaze as input.

1.3.3 TC – 11: "Interactive system to unlock accessibility capabilities in the XR environment"

Modern XR technologies can support people with special needs. This technical challenge welcomes applications that address accessibility issues in XR-enabled manufacturing or learning environments. For instance, technology and tools for real-time monitoring of users' behaviour to better understand their needs or to adjust the interaction to those.

1.3.4 TC – 12: "Open challenge related to user-friendly HRI methods in the workplace"

The last technical challenge is open, giving the applicants the flexibility to provide any XR-related technology that can improve or enable advanced analytics of the interaction with robots in manufacturing or learning contexts. Applicants can combine functionalities covering more than one of the above challenges, or target on other challenges in human-centred interaction design related to HRI and educational interfaces.