V4XR
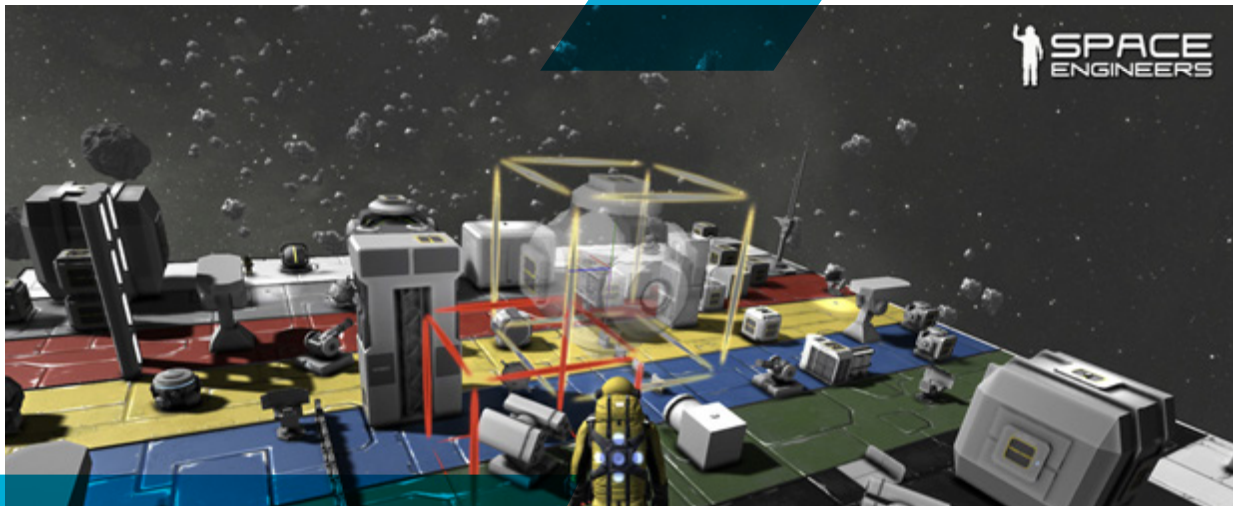
Intelligent Verification / Validation
for Extended Reality Based Systems

/ About iv4XR

iv4XR - Intelligent Verification/Validation for Extended Reality Based Systems - is an H2020 European project focusing on the automated testing verification of extended reality (XR) systems through the use of autonomous and intelligent test agents. The project is in its second year and has so far made important progress in formalizing the problems and contextualizing them along the challenges faced by industrial partners. Solutions are being prototyped and applied gradually to the use cases.

For more information consult the project website

/ A-Test Workshop

iv4XR is co-organizing this year's edition of the A-Test workshop. This workshop is co-located with ESEC/FSE 2021 and will be held virtually on 23-24 of August 2021. The theme of the workshop, among others, is focused on testing eXtended Reality (XR) based systems.

Read the full Call for Papers

Visit the A-Test workshop website

/ Project meetings
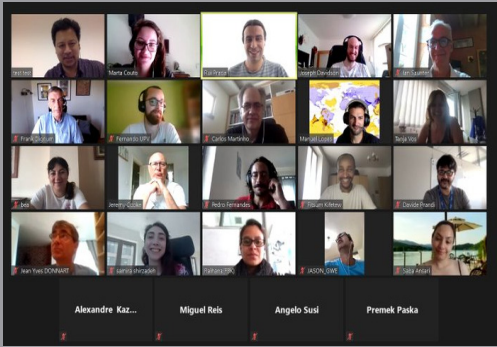
The fifth project meeting was held on 14-15 June, 2021. This time as well, the meeting was held virtually. During the meeting, a detailed discussion session is held for iv4XR WorkPackages (WPs) where milestones, ongoing activities are presented and discussed. Open issues within WPs are identified during this session and were discussed in separate working groups with the aim to identify potential solutions. The dissemination and exploitation activities of iv4XR are also reported which includes dissemination, communication & result management, exploration and valorization, and collaboration with other EU projects. We have identified the next steps including WPs plans, final integration of the pilots, and the upcoming review meeting.

/ Workshop : The future of XR: Current ecosystem and upcoming opportunities

The iv4XR and ARETE projects have organized a workshop The future of XR: Current ecosystem and upcoming opportunities on May 27th.The participation of various EU projects on the field of XR, such as, VR4RehabProject, TactilityP, AI4EU, PRIME-VR2, HOLOBALANCE, AbleGames, AR-4CUP, Mindtooth, VAM realitites, FátimaToolkit, Virtual Reality Ireland. It was an enriching experience and a wonderful opportunity to learn about the ongoing activities in the field of XR. A vibrant discussion session was held to discuss and share the possible dissemination plans, research interests within XR and ideas for future collaboration.

TESTAR at iv4XR

TESTAR is a tool that implements a scriptless approach for completely automated test generation for event-based Systems Under Test (SUT). Once the tool has sufficient information about the characteristics of the states of the SUT and what actions or events the SUT expects in a specific state, it can test the SUT fully automatically, without the use of programmed scripts. This is due to the agents that implement various action selection mechanisms and test oracles. The underlying principles are very simple: generate test sequences of (state,action)-pairs by starting up the SUT in its initial state and continuously selecting an action to bring the SUT into another state.

An integration has already been developed with the iv4xr Framework and LabRecruits game, which allows the TESTAR tool to extract information and create a state that contains the properties of existing virtual entities and execute actions that send instructions back to the Framework and the XR system. Ongoing work is the investigation on the state definition and ways for exploration.

Recently, the first integration of 'Space Engineers' which is one of the pilots of iv4XR is completed with TESTER. 'Space Engineers' is a game about engineering, construction, exploration, and survival in space and on planets. Currently, investigation is going on for improving the action derivation and adding Oracles for the testing of basic tools.

https://github.com/iv4xr-project/TESTAR_iv4xr

Model-based testing

One of the lines being pursued in iv4XR is the use of models to capture the desired behavior of the system under test (e.g., a game) in order to apply testing techniques based on the model. We are currently exploring the use of extended finite state machines (EFSMs) to capture an abstraction of the desired SUT behavior and search-based algorithms are used to derive abstract tests from the model, which are then concretized into action sequences that are executed on the game under test. Prototypical implementation of the tool is now available in the project Github repository, The prototype also includes EFSM models of scenarios from LabRecruits.

https://github.com/iv4xr-project/iv4xr-mbt

Functional test coverage

We are in the process of defining a generic approach for dealing with coverage within iv4XR framework. We are focusing on defining a coverage framework within iv4XR framework which will be applicable to different levels of abstraction and to different pilots. Initial discussion have already carried out for the identification of the test objectives, coverage metrics and measures to obtain.

Reinforcement learning

For different aspects of the project we are exploring the application of reinforcement learning (RL). In particular, we are exploring RL for:

- Testing the system under test to achieve the exploration of different aspects of the behaviour of the system under test (WorkPackage 3).

    > Different Reinforcement Learning strategies are being investigated and implemented in the TESTAR tool where the agent is intended to test the functionality of the XR system through exploration. Currently, we are investigating strategies to optimize the action selection procedure through different reward functions.

    > We are focusing on defining a generic approach for dealing with coverage using RL solutions. In particular, we aim to use RL solutions for automated play testing for iv4XR pilots. Our objective is to automate play testing of games with special consideration to maximize coverage.

    > One of the use cases of iv4XR framework is the verification of the defense strategy of a critical infrastructure against an infiltration. In such scenario, Deep RL approaches are being investigated to aid the adversarial testing where the testing agents try to defeat the defense strategy of a nuclear plant infrastructure.

- Exploring different behavioral aspects and dimensions of the affective perspective related to XR based systems. This includes, but not limited to, exploring collaborative behaviors among test agents (WorkPackage 4)

Automated UX testing

The project is exploring the use of agents endowed with affective and cognitive models to automatically assess User eXperience (UX). The objective is to create agents that can interact with XR environments and modify their internal affective or cognitive models accordingly. This would allow developers and testers to predict how certain changes would impact UX automatically. We are currently exploring how we could use agents endowed with a core-affect model to test different maps of our LabRecruits game. In its current version, the software uses a rule-based approach to model pleasure and arousal of an agent that traverses a level/scenario. The next step will be to include bio-sensors to measure physiological parameters during an interaction. We are also testing a cognitive load model to create a toolset that will provide designers with a measure of the working memory resources being engaged when a user is interacting with a system. To test our cognitive load model, we created a game called WayOut.

https://github.com/iv4xr-project/userexperienceeval
https://github.com/albertoramos1997/WayOut

Integration of use cases (iv4XR pilots)

The intermediate integration of project pilot with the agent-based iv4xR testing framework is completed. This integration is defined as "two-way communication" between the framework and pilots. Here, all the pilots are able to communicate with an agent hosted in the iv4XR framework and allow the agent to make decisions and to interact with the pilot based on observations supplied by the pilot systems.

In this integration, the Space Engineers pilot, there is support for observing the world as well as making basic movements. The integration also allows performing basic actions in the game such as placing objects as well as some basic construction (such as, placing block, grind it with a tool to damage it until a certain health threshold is passed, then weld it with another tool to repair it fully).

https://github.com/iv4xr-project/iv4xrDemo-space-engineers

Similarly, the pilot from Thales on intrusion detection has been integrated into the iv4XR platform. The prototype implementation of the integration allows some basic commands to be exchanged between iv4XR and the pilot application. It is available in the project Github repository.

https://github.com/iv4xr-project/iv4XR-IntrusionSimulation

For the LiveSite pilot, a server-side tool is developed which can interface with the iv4XR framework. Its inputs are monitoring projects with sensor definitions, thresholds, and their varying requirements, and it uses the IV4XR framework to test parameters within the definition of the given sensors.

/ Collaboration with other projects

We have established collaborative efforts with a number of other projects. One of these projects with which we have established a synergy is the H2020 ARETE project. The ARETE H2020 project (https://www.areteproject.eu) aims to support the pan-European interactive technologies effort both in industry and academia, through the multi-user interactions within Augmented Reality technologies evaluated in educational settings in both professional and private contexts. The authoring tool used within ARETE is based on the Mirage. XR Community Edition, Open Source for authoring and re-enactment of AR learning content to scale down mobile platforms. Within the three pilots of the ARETE project, highly usable, useful and desirable AR technologies and contents will be delivered, leading to a wider uptake and further stimulate their creative usage.

We will report on other collaborative efforts in upcoming editions of our newsletter.

/ Check out our channels

We have set up various channels where we regularly disseminate updates and progress on our project. Follow us on your preferred channel:

Twitter: https://twitter.com/iv4xr

Facebook: https://www.facebook.com/iv4xr

LinkedIn: https://www.linkedin.com/company/iv4xr-project

GitHub: https://github.com/iv4xr-project

Zenodo: https://zenodo.org/communities/iv4xr-project