Virtual World and Performing Arts

Towards Interactive and Distributed Hybrid Extended Reality Experiences

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Motivation

- Performing arts are creative arts that are performed by individuals or groups in front of a live audience.
- The performing arts industry is varied, consisting of professional as well as amateur performance organisations and theatres.
- Performing arts are intrinsically human-centred: actors, dancers, musicians, singers, etc. interpret the artistic streak of creative authors arousing emotions in the audience.
- Performing arts are conceived as a social experience, with the physical experience, emotional connection, and ephemerid as their strong values and at the same time their limitations for a direct digital transformation that it is strongly limiting important opportunities such as widening their audience and impact and, in some cases, even the potential of connecting with new generations.

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Motivation

- Social interaction has been reduced during the pandemic dramatically, when traditional in-presence habits of working/learning/entertaining have necessarily been translated to remote/blended mode and when multi-user virtual communication and collaboration solutions have gained popularity instead.
- The limitation of the remote/blended approach is mainly related to the inadequacy of the traditional fruition of the audio-video content: PCs, laptops, tablets, TV sets have limited potential to fully and accurately represent real scenarios.
- 3D scenarios, dynamic volumetric representation of users, stereoscopic 2D, 180º/360º videos, point cloud/holographic imaging are considered more suitable candidates to reproduce highly realistic experiences.
- True realistic contents should also include media with multiple sensorial effects (i.e., mulsemedia) aimed at increasing the user's experience through the five senses representation (i.e., taste, sight, touch, smell, and hearing), as the real world is perceived.

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Motivation

- The potentiality of the above technologies is far from being fully exploited, especially due to the lack of a "system perspective" where the technological integration could really make the difference in enabling true immersion and almost-real interaction based on the effective exchange of social cues and proper rendering of user feedback.
- More often, especially in real-time performance scenarios (e.g., live performance, blended learning), real needs are for hybrid eXtended Reality (XR) applications.
- In hybrid XR users can experience a real captured environment through immersive XR, while in presence users can visualize and interact with the holograms of remote users integrated in the real environment through holographic rendering.

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Motivation

- Such interactive hybrid and multi-sensory scenarios have not been fully considered so far and pose three main issues to be faced:
    1. How can remote users be brought together by capturing and presenting their 3D holograms in a real in presence environment? That is, how can next-generation multimedia and immersive content be effectively processed and delivered over hybrid XR scenarios using low-complexity and low-cost devices?
    2. How can the real in presence environment (audio-visual and multi-sensory) be realistically 3D captured and presented to remote users?
    3. How can in presence and remote users interact? That is, how can remote user's feedback (e.g., social cues, emotions, ratings, etc.) be conveyed to the in-presence users and vice-versa?
- HEAT is born to effectively answer the above questions, paving the way for the next-generation distributed experiences.

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HEAT - Hybrid Extended reAliTy

- Call: HORIZON-CL4-2023-HUMAN-01-CNECT- A human-centred and ethical development of digital and industrial technologies
- Topic: HORIZON-CL4-2023-HUMAN-01-21- Next Generation eXtended Reality
- Type of action: HORIZON Research and Innovation Actions (RIA)
- Total budget value: € 6 993 207.50
- Project starting date: 1 June 2024
- Project duration: 36 months

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HEAT - Consortium

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Ambition

- HEAT vision and ambition in the performing arts sector is to exploit and demonstrate the full potential of interactive and XR technologies, by enabling rich hybrid multi-modal experiences with increased engagement and reach, in a modular, replicable and cost-efficient manner.
- HEAT has been conceived around six main pillars to lay the foundation for the new envisioned media ecosystem in the context of real multi-user social XR experiences:
  - volumetric capture and reconstruction
  - 3D visualization techniques
  - multi-sensory technology
  - user feedback conveying and rendering
  - adaptive delivery and multimodal integration
  - quality of experience

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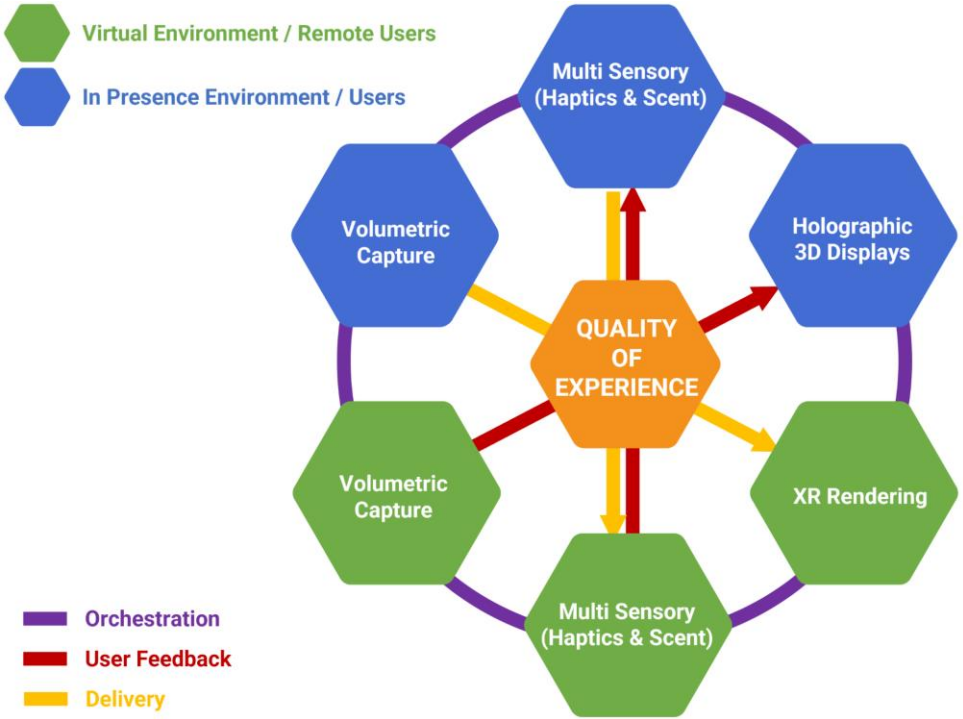
Main components



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Application scenarios

- HEAT will provide well designed and fully tested performing arts scenarios in real-world environments for enhanced XR experiences: a modern theatre act, a music festival, and an opera show.
- The pilots will be used to validate the applicability and effectiveness of the proposed system through test assessment that will aim at estimating the perceived user's QoE, as well as readiness and acceptability of HEAT's contributions.
- All pilot actions will ensure that GDPR and ethics are addressed for end-users (privacy and ethics by design methodology).

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Pilots' commons

- The whole in-presence environment (i.e., humans and background) will be captured with volumetric cameras, microphones and multi-sensory acquisition devices.
- The background will be statically captured offline.
- The humans' hologram will be dynamically captured and combined with the offline captured background.
- Remote users will experience the environment together with the in-presence users, via XR headsets and multi-sensory actuators (i.e., olfaction dispensers, haptic gloves/vests), like being seated in a specific position upon their request.
- The remote users will be captured at their site, using available devices (e.g., 360°/plenoptic cameras/stereo microphones from smartphones or dedicated cameras), being their hologram tele-ported in the environment via 3D holographic displays and/or XR headsets.

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Example of Scenarios

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“On the wild” volumetric capture

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XRTheater pilot

- The SART facilities and productions will be used to implement this pilot.
- The holographic displays will cyclically show the realistic hologram of the remote users to provide visual social cues (e.g., clapping hands, “bravo” appreciation) to the performers.
- Remote audience social interaction and feedback will be allowed both during the performance (e.g., interactive storytelling) acts and at the end of the whole performance, to allow interaction between the actors and the audience, frequently used in modern acts.
- The multi-sensory feedback (e.g., haptic, heart bit) from remote audience will be acquired and the possibility of dynamic rendering to the performers via wearable devices will be investigated.

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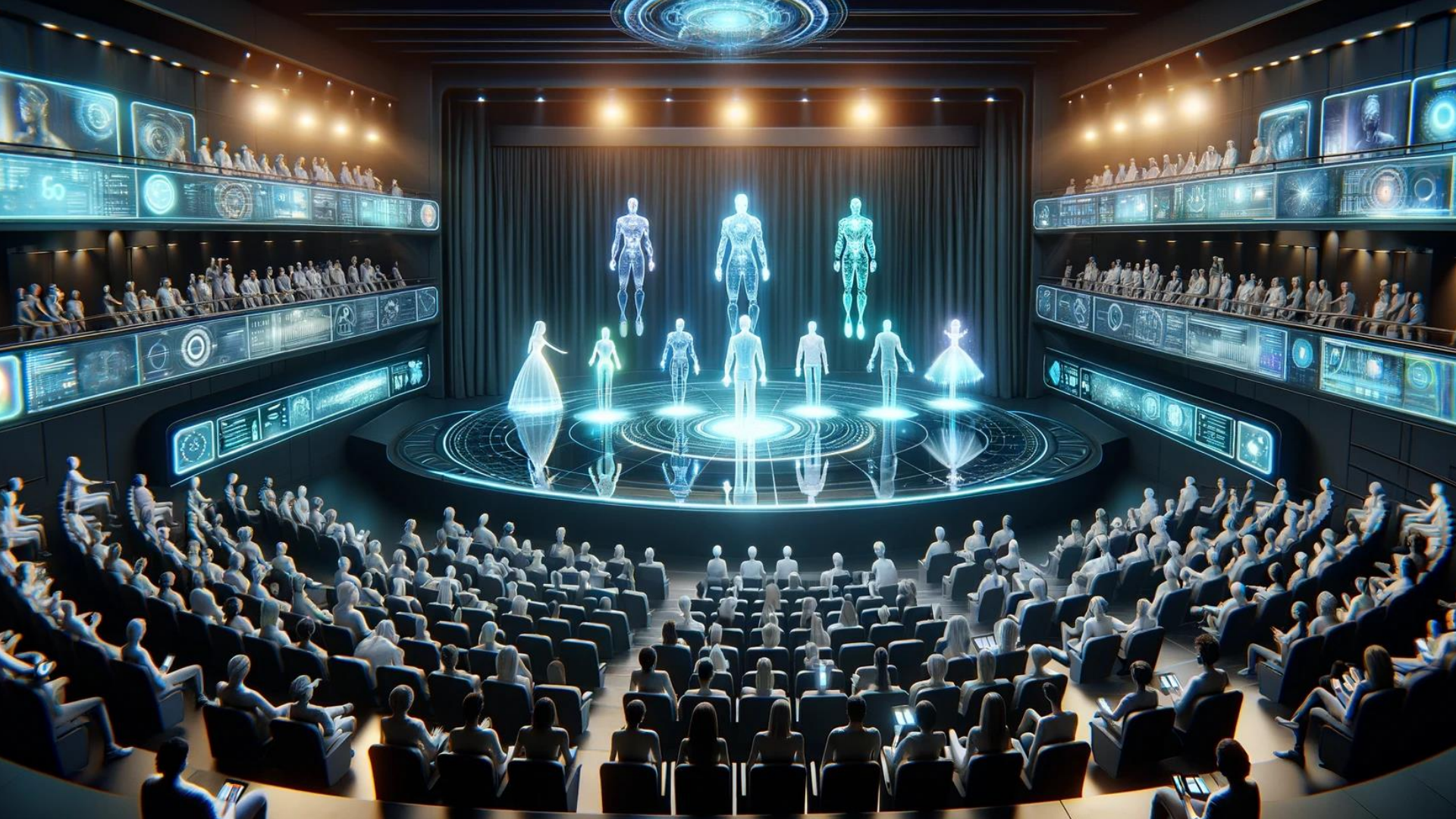

XRBlues pilot

- ATRAE, organizer of the *Transilvania Blues Festival*, will host this pilot and collaborate in the specific design and in the validation phases.
- The holographic displays will cyclically show the holograms of the remote audiences to provide visual social cues (e.g., clapping hands, whistles, singing) to the musicians.
- Multi-sensory feedback from audience (e.g., haptic, heart bit) will be acquired and the possibility of rendering to the musicians in the stage via wearable devices will be investigated.
- The remote audience will have the possibility to dynamically switch their viewpoint and vary their multi-sensorial experience based on their position with respect to the stage.
- A standalone (SA) 5G cell will be used for the data traffic to and from the live performers, with edge processing capabilities to minimize the latency and maximize bandwidth availability.

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XROpera pilot

- INO facilities and opera/orchestra events will be used to implement this pilot.
- INO will produce an operatic experience with operatic directors and other artistic professionals, briefing them to stage a variety of scenes from the operatic canon, presenting them in a way in which the technology explored is showcased and aids the narratives of the scene in question.
- Artists will be briefed to design scenes in which the experience is fundamentally captured offline, but the piece has a portion of either the audience or performers taking part in a remote capacity who also have the ability to interact with the scene in some way (e.g., the use of holograms for a scene featuring ghosts).
- OPEU will also be involved in the co-design as the Opera Vision platform will be considered for multicast/broadcast delivery purposes.

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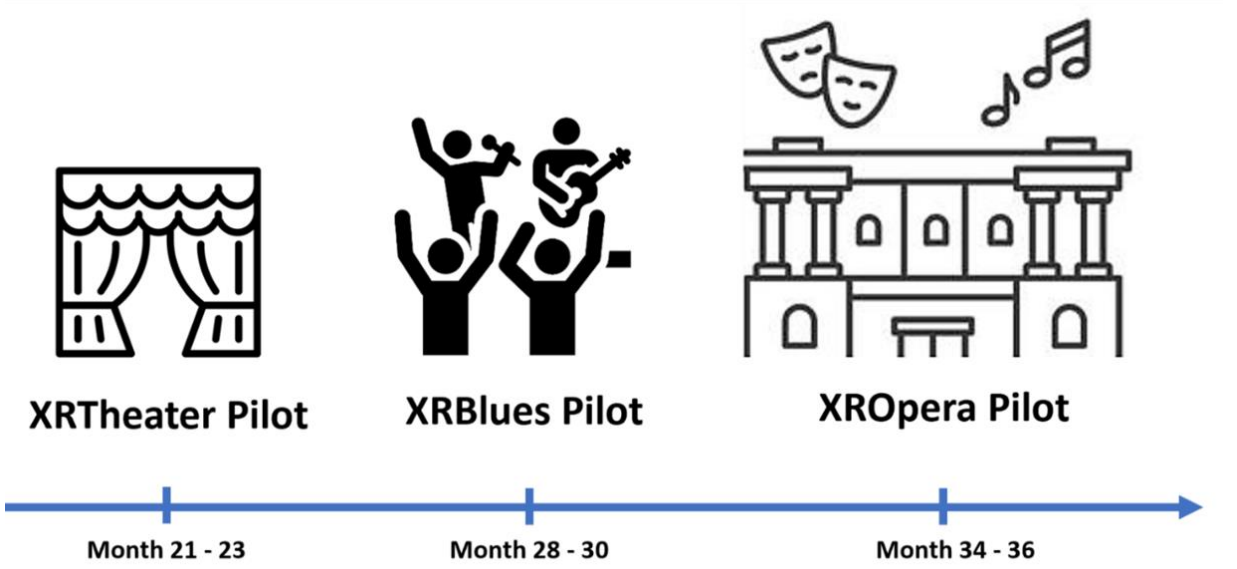
Pilots Timeline



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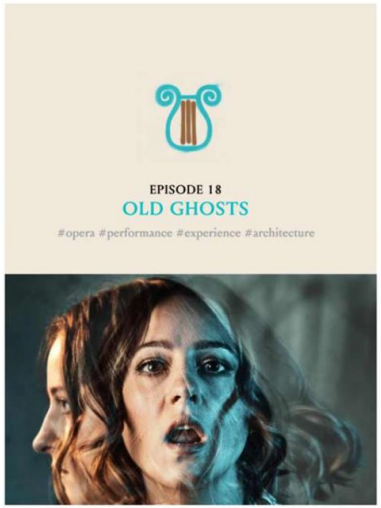
Real World Scenarios



Irish National Opera

sardegna teatro

TRANSILVANIA
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Pilots' assessment

- The implementation of the four pilots is expected to involve more than 100 remote users and more than 30 professionals in-presence users among actors both from theatre, opera and musicians.
- This will allow for IT researchers and SSH experts to perform sets of measurement campaigns and, thus, to collect new datasets that will enable training and validation of AI algorithms aiming at defining novel QoE metrics for hybrid XR applications.

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Conclusion

- HEAT is born to pave the way for the next-generation distributed experiences by leveraging recent advances and lessons learned but, most importantly, by addressing major challenges to realizing those experiences that up to now could only be in our imagination.
- The main objective of HEAT is to enable hybrid multi-user eXtended Reality (XR) experiences through real-time holographic telepresence (i.e., holo-portation) in hyper-realistic 3D volumetric captured environments and interactive multi-sensory user feedback (e.g., social cues, emotions, ratings etc.).
- HEAT is an interdisciplinary project: expertise from scientific, technical, SSH, creative and artistic partners.
- HEAT's outcome shall be the base for future actions to strengthen the ability of European cultural and creative industries (CCIs) of performing arts to contribute to a human-centred digital transition by enabling effective and cost-efficient interactive and hybrid multi-user XR experiences.

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Thank you

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