Blönnigen, Justus; Clarke, Christopher; Dahn, Andreas; Forelli, Lisa; Gowrishankar, Ramyah; Heikura, Tuija; Helzle, Volker; Hine, Paul; Jicol, Crescent; Kreische, Alexander; Lutteroth, Christof; Macía, Francisco; Moesgen, Tim; Pares, Narcis; Plichta, Leszek; Potts, Dominic; Schäfer, Eduard; Sharma, Adwait; Spielmann, Simon; Tenhunen, Juhani; Trottnow, Jonas; Tseng, Yu Han; Vikberg, Esa; Xiao, Yu

Accelerating XR Innovation through a pan-European Lab Network: An overview of the EMIL project

Published in:
IMXw 2024 - Proceedings of the 2024 ACM International Conference on Interactive Media Experiences Workshops

DOI:
10.1145/3672406.3672426

Published: 12/06/2024

Document Version
Publisher's PDF, also known as Version of record

Accelerating XR Innovation through a pan-European Lab Network: An overview of the EMIL project

Justus Blönnigen[1], Christopher Clarke[2], Andreas Dahn[1], Lisa Forelli[1], Ramyah Gowrishankar[3], Tuija Heikura[3], Volker Helzle[1], Paul Hine[4], Crescent Jicol[2], Alexander Kreische[1], Christof Lutteroth[2], Francisco Macía[4], Tim Moesgen[3], Narcis Pares [4], Leszek Plichta[1], Dominic Potts[2], Eduard Schäfer[1], Adwait Sharma[2], Simon Spielmann[1], Juhani Tenhunen[3], Jonas Trottnow[1], Yu-Han Tseng[3], Esa Vikberg[3], Yu Xiao[3]

[1] Filmakademie Baden-Württemberg
Germany
[2] University of Bath
United Kingdom
[3] Aalto University
Finland
[4] Universitat Pompeu Fabra
Spain

ABSTRACT

European Media and Immersion Lab, or EMIL, is a pan-European network of extended reality (XR) labs consisting of 4 European academic institutions, with a mission to accelerate development of virtual, augmented and mixed reality technologies, content, services and applications. The 30-month project, which started in September 2022, has been funded by the European Union and co-funded by Innovate UK. This paper gives an overview of the project's goals, its organization, and selected results that have been achieved.

CCS CONCEPTS

• **Human-centered computing** → **Interactive systems and tools**.

KEYWORDS

Extended reality, immersive media, FSTP

ACM Reference Format:
Justus Blönnigen[1], Christopher Clarke[2], Andreas Dahn[1], Lisa Forelli[1], Ramyah Gowrishankar[3], Tuija Heikura[3], Volker Helzle[1], Paul Hine[4], Crescent Jicol[2], Alexander Kreische[1], Christof Lutteroth[2], Francisco Macía[4], Tim Moesgen[3], Narcis Pares [4], Leszek Plichta[1], Dominic Potts[2], Eduard Schäfer[1], Adwait Sharma[2], Simon Spielmann[1], Juhani Tenhunen[3], Jonas Trottnow[1], Yu-Han Tseng[3], Esa Vikberg[3], Yu Xiao[3]. 2024. Accelerating XR Innovation through a pan-European Lab Network: An overview of the EMIL project. In *Proceedings of the 2024 ACM International Conference on Interactive Media Experiences Workshops (IMXw '24), June 12, 2024, Stockholm, Sweden.* ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3672406.3672426

IMXw '24, June 12, 2024, Stockholm, Sweden

ACM ISBN 979-8-4007-1794-9/24/06
https://doi.org/10.1145/3672406.3672426

1 INTRODUCTION

Recent advancements in Virtual, Augmented, and Mixed Reality (VR, AR, and MR) have blurred the line between the physical and virtual worlds, creating immersive eXtended Reality (XR) experiences. Key factors driving these developments include the improved accessibility, quality, and user-friendliness of XR devices, along with innovations in motion/emotion capture, game engines, haptic feedback systems, content platforms, and networking technologies. These developments unlock a spectrum of creative possibilities across industries, fueling the proliferation of XR applications — from entertainment and education to healthcare and manufacturing. However, realizing the full potential of XR requires overcoming funding constraints and bridging the gap between technological expertise and creative practice.

To tackle these obstacles, the EMIL project secured funding to establish a pan-European XR lab network aimed at accelerating the development of XR technologies, content, services, and applications for the media. EMIL is operated through four esteemed European academic institutions, including Aalto University (Aalto), Filmakademie Baden-Württemberg (FABW), Universitat Pompeu Fabra (UPF), and the University of Bath (Bath), each serving as an EMIL node. These nodes contribute cutting-edge facilities, technological and creative expertise, and extensive networks to support groundbreaking XR projects and foster innovation.

The budget of the EMIL project is allocated in two ways. Approximately 70% of it is earmarked for providing financial support to third parties (FSTP). The remained budget is mainly allocated for executing open calls for FSTP projects, for monitoring, supporting and evaluating the implementation of funded FSTP projects, and for implementing four lighthouse projects, alongside with project management, dissemination and exploitation activities. This paper gives an overview of the organization of the EMIL project and highlights selected results achieved in the first half of the implementation.

2 LIGHTHOUSE PROJECTS

Each EMIL node creates a lighthouse project around one of its core component: Smart Garments, Embodied Interaction, Digital Health, and Narrative Storytelling. These lighthouse projects, as illustrated in Figure 1, span key emerging areas of XR within the creative industries, serving as focal points and central hubs for FSTP proposals.

2.1 Smart Garments - Wearable Haptic Devices for Enhancing User Experience in VR

Haptic feedback tries to replicate diverse human sensations, such as weight, textures, temperatures, and even pain. It has proved to significantly enhance immersive experience and has attracted tremendous attention from both academia and industry. Commercial haptic gloves are mainly designed to provide force feedback and in some cases also texture sensation in specific VR applications like simulation-based pilot training. From the texture sensation perspective, existing devices have focused on simulating the feel of solid objects in VR. However, the research on liquid-based and thermal haptic experiences is still in its infancy, with only limited examples available currently.

The primary objective of this lighthouse project carried out by Aalto Wearable Systems Lab is to lead the way in developing smart garments that integrate vibrotactile, thermo-tactile, and potentially also chemical stimulations to create diverse haptic experiences. As a focal point, we have selected a virtual sauna game augmented with thermos-tactile feedback as a case study. The sauna game replicates the physical phenomena of heat transfer and fluid dynamics. Within this virtual environment, the sensation of liquid is authentically recreated using thermo-tactile and vibrotactile feedback, immersing players in the experience of steaming and sweat dripping during sauna sessions. By selecting this case study, we can delve into the intricate design aspects of wearable haptic devices, showcasing how the interplay between tactile sensations and complementary sensory modalities such as vision, audio, and scent can elevate the sense of immersion and embodiment experienced by users.

As a significant achievement of this lighthouse project, a modular, open-source platform for wearable thermo-haptic devices, has been developed. It enables seamless prototyping of thermo-haptic interactions and effortless integration with XR applications through user-friendly APIs [1]. The hardware and API specifications [6] are publicly accessible.

2.2 AR Magic Lantern - Shared, Co-located Group-oriented Experience for Public Spaces

Starting with the World-as-Support (WaS) AR paradigm in 2015, the AR Magic Lantern is the product of ongoing research conducted by the Full-Body Interaction Lab at UPF. The typical AR paradigm is that of "Window on the World" (WoW). WoW clamps the attention of the user on the screen of a mobile device and therefore places a barrier between the user and the physical world which is being augmented. The WaS paradigm, on the other hand, is based on projective augmentation in which the mobile device becomes a sort of "magic lantern or flashlight". The device not only recognises the geographic location of the user to determine what needs to be projected, but also understands the geometry and properties of the physical environment to adapt the projected output to that specific space. In this manner, the "world" not only becomes literally the support for the augmented information that is being projected, but also becomes the "primordial content" which then acts as a conceptual support for the "augmentation content". As a result, the physical space would become the main focus of attention and makes the visit to the specific site worth the effort.

The AR Magic Lantern comprises various sensing, computing, and projection modules. A hardware prototype includes at least an Intel RealSense D455 depth camera, an E4500MKII projector, an Orange Pi 5B compute module connected via Ethernet to a LattePanda 3 Delta tracking computer, a voltage step-down converter module, and a power source. Equipped with an advanced visual tracking solution, the AR Magic Lantern can accurately track its position and orientation across large areas without using external markers or beacons. More detailed description of the hardware design, the integration with Unity, and the enabling computer vision techniques can be found from [5]. The SDK for creating AR experience for the AR Magic Lantern is available online [2].

The AR Magic Lantern seamlessly integrate projected content with the physical space, ensuring the relevance for all group members. Through embodied interaction, both Lantern holders and other participants can engage in interactive experiences without the need for external buttons or controllers. Such a device is well-suited for creating shared, co-located group-oriented experience in public spaces, such as virtual heritage sites and digital tourism destinations.

2.3 Exergaming - Integration of Physical Activity into VR Experiences

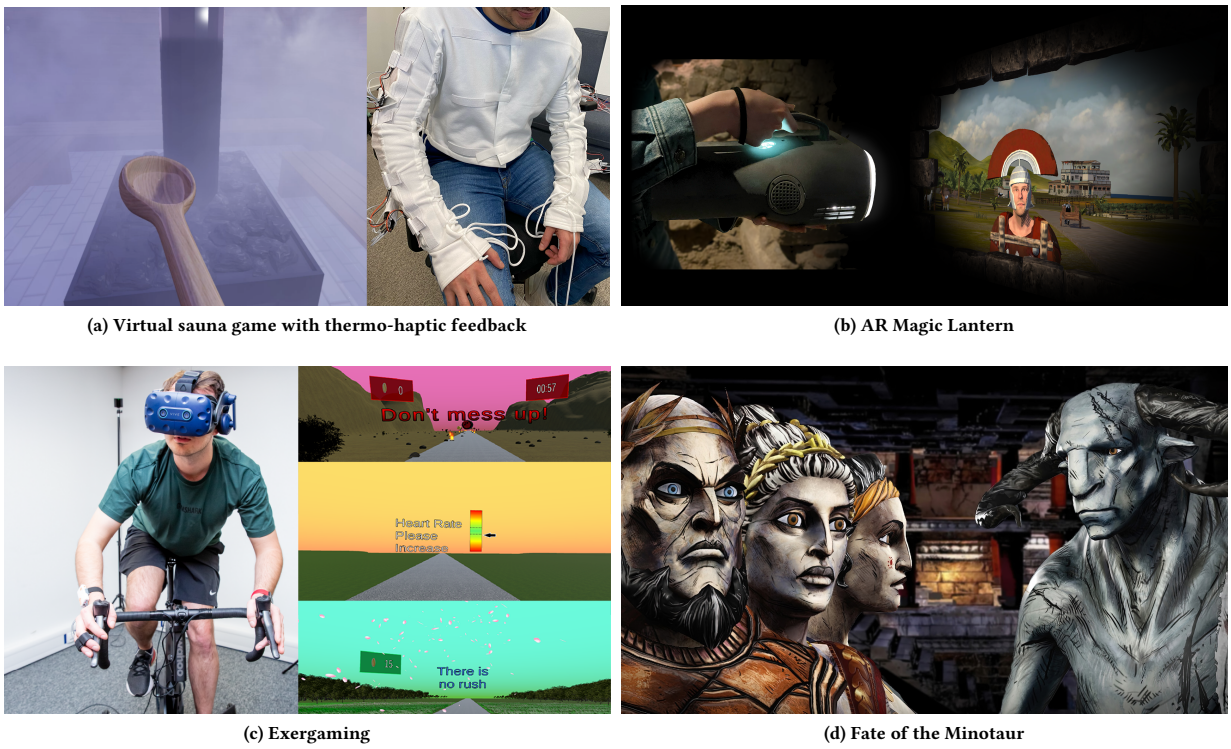
Virtual environments hold great promise in supporting users to be physically active. By integrating physical movement and activity into virtual scenarios, we can create unique and immersive experiences that get the heart racing. For example, the technologies developed in this lighthouse project will enable users to interact naturally in virtual environments by cycling on an exercycle or by running and jumping on the spot. Additionally, by sensing and detecting a user's feelings and emotional response to the exergame, the experience can be enhanced by adjusting the difficulty in order to support and encourage continued engagement. In this lighthouse project, Bath is developing technologies to enable gamified exercise ("exergames") in an effective and motivating manner by combining physical activity with how users feel ("affect") to adjust and optimise virtual environments accordingly. Two VR applications, including cycling sport training and stroke rehabilitation, have been selected to demonstrate and evaluate the potential of affective exergaming in enhancing training or rehabilitation outcomes.

This lighthouse project produces Software Development Kits (SDKs) for seamlessly integrating physical activities (such as walking-in-place, cycling, and using a crosstrainer) and affect recognition [3] into VR experiences. The former detects physical activities solely

[1] https://version.aalto.fi/gitlab/vikbere2/wearable-device-api

[2] https://github.com/fubilab/arml-sdk

[3] https://github.com/RevealBath/EmoSense



(a) Virtual sauna game with thermo-haptic feedback

(b) AR Magic Lantern

(c) Exergaming

(d) Fate of the Minotaur

Figure 1: Overview of the lighthouse projects

based on headset movements [2], while the latter captures real-time physiological measures and generates a confidence value for predicted core affect based on categorical and dimensional emotion models [3]. Supported physiological measures include pupillometry, gaze and head movement, heart rate and heart rate variability, galvanic skin response, and facial/lip gestures. Additionally, the SDK includes software for baseline and calibration measures across all physiological signals, aiding in data cleaning and normalization between users. These SDKs help developers and content creators to design innovative exergaming products and services.

2.4 Scalable Narrative Location Based Experience

Location-Based XR (LBX) offers users access to a wide range of immersive experiences, ranging from seated single-player scenarios to free-roaming multiplayer adventures. Modern head-mounted displays (HMDs) enable usage without additional hardware, although they can be combined with backpack PCs or Wi-Fi streaming to support compute-intensive audio-visual content. Though LBX presents numerous opportunities for innovative applications and services, location-based systems are rare and require significant maintenance. Typically, this entails complex and dedicated setups at specialized locations. Moreover, there are few examples of LBX experiences that offer compelling storytelling alongside immersive capabilities.

In this lighthouse project, FABW is dedicated to creating a scalable narrative LBX that immerses users in a compelling story world. The FABW team is developing three distinct experience formats: individually seated, individually in a room-scale environment, and group experiences in large environments. On April 4, 2024, FABW released the official trailer for the narrative LBX, 'Fate of the Minotaur' [1].

Unlike existing action-oriented games, 'Fate of the Minotaur' - based on the myth of the Minotaur - delves into the narrative depth and emotional resonance of the original myth. Our aim is to engage general audiences in an adventurous story world and make them relate to it emotionally, regardless of their familiarity with Greek mythology. In 'Fate of the Minotaur', players assume the roles of human sacrifices from Athens, dispatched to the Isle of Crete to face the Minotaur in its labyrinth. On Crete, they encounter Ariadne, the Minotaur's half-sister, who urges them to kill the Minotaur so they can flee the island together. Yet, players also encounter Pasiphae, the Minotaur's mother, who begs for mercy for her son. Ultimately, players must decide whose side to take. More details including the story, design, interaction mechanics, technical implementation, and the public demonstrator of the November 2023 prototype of this scalable interactive multi-user LBX experience are available on the EMIL project website [4].

3 FINANCIAL SUPPORT TO THIRD PARTIES (FSTP)

During its runtime the EMIL consortium has been provided with a total of 5,600,000€ to be distributed to Europe's most innovative

XR projects through the FSTP initiative. This funding is aimed at supporting media innovators, exceptional technology developers, SMEs, academia, and others facilitating new ways for creative storytelling and interaction via immersive media technologies. Selected projects, with a duration of 15 months, may receive funding ranging from 250,000€ to 500,000€. This funding covers 100% of the project's applied costs, and certain resources of EMIL nodes are available to projects in addition to the funded sum.

3.1 Organization of Open calls

EMIL has conducted two open calls for funding, which closed in January and August 2023, respectively. These calls follow a one-stage application process and were published on the EMIL project's website [4] and the Funding and Tenders portal. Proposals must be submitted by legal entities located within an EU member state or a Horizon Europe associated country. EMIL invited proposals especially for areas related to the Core Competence of the EMIL nodes and the four Lighthouse projects that reflect the expertise and supporting infrastructure of EMIL. However, proposals outside of these areas were also welcomed and evaluated. In total, the calls received 244 proposals from 28 European Union and associated countries.

Proposal review was guided by principles of relevance, transparency, equity, efficiency, quality, and independence, as well as best practices outlined in the European Science Foundation Peer Review Guide. A minimum threshold of 3 out of 5 was required for each of the following 5 criteria. Proposals needed to score at least 17 out of 25 to be ranked.

- **Excellence and relevance:** Extent to which the objectives of the FSTP Project are consistent with the EMIL-HORIZON-CL4-2021-HUMAN-01-06 call objectives.
- **Quality**: Extent to which the FSTP Project's objectives are expected to be achieved, taking into account their relative importance.
- **Implementation:** Extent to which the FSTP Project complements and takes advantage of EMIL consortium's capabilities and helps the establishment of a permanent European XR network.
- **Efficiency:** Extent to which the outputs and/or desired effects have been achieved with the lowest possible use of resources/inputs (funds, expertise, time, administrative costs, etc.).
- **Impact and Sustainability:** Positive and negative, primary and secondary long-term effects produced by the FSTP Project, directly or indirectly, intended or unintended; Extent to which the benefits from the FSTP project continue after the funding period, or the probability that they continue in the long-term in a way that is resilient to risks.

The EMIL Programme Committee (PC) coordinates the lifecycle of the open calls and funded FSTP projects. The PC is led by Aalto and composed of the Content Project Manager and at least one scientific expert from each EMIL node. The evaluation process comprised the following steps:

(1) The Programme Committee (PC) conducted the eligibility check. These checks continued to take place alongside the following steps.
(2) An international Independent Experts Panel (IEP) was assembled for each proposal to ensure alignment with their focus. Proposals were evaluated by at least two international independent experts in the field, considering a balance between academia and industry, and striving for gender parity whenever feasible.
(3) The evaluation reports were first created by each IEP member independently according to the evaluation criteria. After that, the PC consolidated individual IEP reports for each FSTP proposal.
(4) Technological experts at EMIL Nodes assessed the technological feasibility of the proposals and the availability of resources requested by proposals from the Nodes during execution.
(5) In cases where specific evaluation was found necessary, an expert from EMIL's Expert Advisory Group (EAG) was asked to review the proposal to further modulate the final score. The EAG comprises experts from participating universities and industry contacts, representing the core areas of EMIL. Additionally, they provide insights from AI and social sciences.
(6) The PC compiled a final ranked list of proposals based on global grades as per the previous steps and proposed this list for funding to EMIL's General Assembly.
(7) Once ratified by the General Assembly, the list was submitted to the EU project officer for final review before its publication on the EMIL website.

3.2 Overview of the Funded FSTPs

The first open call resulted in the funding of two FSTP projects: CAPARE and XR-Pain. The second open call led to the selection of an additional 11 projects. These projects cover a wide range of services, applications and content.

- **CAPARE** by Vrije Universiteit Amsterdam aims to develop and clinically validate a home-based Cueing-Assisted Personalized AR Exergaming program for improving gait and balance in people with Parkinson's disease, exploiting AR data science to monitor their progress remotely.
- **XR-Pain** by Institute of Biomedical Research August Pi i Sunyer (IDIBAPS) uses VR to treat chronic low back pain with a personalized virtual body and a virtual physiotherapist. A clinical trial is scheduled to test the prototype.
- **AARDMAN & FRIENDS** The immersive exhibition by Atlas V presents an all-encompassing visual journey into the universe of Aardman Animations, bringing their cherished characters to life. Visitors can experience a novel narrative within a 360°panorama, where iconic moments from Shaun the Sheep and more come alive.
- **CINEVERSE** by Arilyn aims for enabling film production and distribution companies to scale the industry into the interactive 3D internet era. This is done by developing online tools for creating online virtual productions.

[4] https://emil-xr.eu/open_calls

- **Climate Change VR** by Pixelcloud offers an episodic, satirical multiplayer VR action-adventure to overcome adversaries and solve physical puzzles in a collaborative manner, all while gaining insights into the root causes of the climate crisis and improving the user's ability to navigate misinformation.
- **coopXscape** by Polycular is an immersive XR game that improves teamwork across remote and co-located teams. It uses storytelling and play to gain deeper insights into empathetic yet effective team communication and collaboration.
- **GameRAT** by Metropolia UAS develops a remote rehabilitation system, including XR solution for patients and web-based tools for professionals. The aim is to offer modular, scalable solutions for rehabilitation to improve quality of life.
- **GANIMATEER** by MOVERSE PC is an animation toolset that receives interpretable user manipulations and delivers realistic 3D character animation edits / generations.
- **IERCEP** by Broomx tries to elevate the field of elderly rehabilitation to unprecedented levels. It seeks to achieve this through the creation of innovative exergames, tailored for individuals aged 65 and above.
- **iXR** by Reality Crisis aims to evolve its real-world sensing gaming platform to enhance content creation for groundbreaking XR experiences, leveraging AR, AI, and geolocation services to create lifelike interactions with the environment.
- **PROJECT REMBRANDT** by SenseGlove aims to develop a high-precision telepresence glove with a production-ready prototype. Derived from extensive client interviews, the key requirements include mm-precise fingertip position measurement, active force-feedback with pressure sensing, and user-friendly functionality.
- **VirtualR3** by Universidade de Vigo proposes a combination of cable-driven robotics (to accompany the patient's movements) and VR (interactive scenes) to set an environment for more effective, enjoyable, and motivating lower limb rehabilitation exercises.
- **XR-IT** by Design Academy Eindhoven aims to develop a toolkit that will significantly simplify (in terms of both time and specialist technical knowledge required) how a node in a network can join and participate in a Networked XR collaboration scenario.

3.3 Mentoring of FSTP projects

The EMIL nodes are actively supporting and guiding the funded FSTP projects towards their objectives. Each funded FSTP project has been assigned a supervisor EMIL node and an interlocutor from that node. This interlocutor serves as the main contact between the FSTP project, EMIL services, and Lighthouse projects, offering concrete support for any arising issues, including logistics, access to technology or infrastructure, issue resolution contacts, and conceptual guidance. Furthermore, each FSTP project benefits from a local mentor provided by the supervisor EMIL node, addressing technical aspects and project needs. Business mentors are also available when required. Additionally, EMIL fosters a vibrant online community on LinkedIn and organizes networking events to showcase the progress of FSTP projects. These initiatives provide teams with opportunities to connect with other stakeholders from the content and media industries.

4 SUMMARY AND OUTLOOK

EMIL seeks to foster a robust relationship with the creative industry community through initiatives like the FSTP calls and facilitating collaborations with potential innovation partners across Europe. As EMIL progresses through its initial 30-month phase until Q2 2025, we are proactively exploring opportunities to prolong both EMIL and its FSTP funding framework beyond the project's conclusion. Our objective is to ensure the sustained impact and longevity of EMIL's initiatives in the XR domain, nurturing a vibrant XR ecosystem for the European digital market.

ACKNOWLEDGMENTS

This work is supported by the European Union's Horizon Europe research and innovation program and Innovate UK under grant agreement No 101070533, project EMIL (The European Media and Immersion Lab): https://emil-xr.eu/.

REFERENCES

[1] Filmakademie Baden-Württemberg. 2024. *EMIL Lighthouse Spotlight: Narrative Location Based Experience - Fate Of The Minotaur Trailer.* https://www.youtube.com/watch?v=_fUO3l2rbwo

[2] Crescent Jicol Christof Lutteroth, Christopher Clarke and Adwait Sharma. 2023. *DRAFT D3.6 – SDK for integration of physical activities into VR experiences.* https://emil-xr.eu/wp-content/uploads/2023/03/DRAFT-D3.6-âĂŞ-SDK-for-integration-of-physical-activities-into-VR-experiences.pdf

[3] Crescent Jicol Adwait Sharma Christof Lutteroth, Christopher Clarke and Dominic Potts. 2023. *DRAFT D3.7 – SDK for integration of affect recognition into VR experiences.* https://emil-xr.eu/wp-content/uploads/2024/04/D3.7-SDK-for-integration-of-affect-recognition-into-VR-experiences.pdf

[4] Volker Helzle Alexander Kreische Leszek Plichta Eduard Schäfer Justus Blönnigen, Andreas Dahn and Simon Spielmann. 2023. *D3.11 – Location Based Experience Demonstrato.* https://emil-xr.eu/wp-content/uploads/2024/04/D3.11-Location-Based-Experience-Demonstrator.pdf

[5] Renato Muñoz Paul Hine and Narcis Pares. 2023. *DRAFT D3.3 – Hardware integration and Adaptation of foundation libraries of AR Magic Lanterns.* https://emil-xr.eu/wp-content/uploads/2024/04/D3.3-Hardware-integration-Adaptation-of-foundation-libraries-of-AR-Magic-Lanterns.pdf

[6] Yu-Han Tseng Esa Vikberg Ramyah Gowrishankar, Tim Moesgen and Yu Xiao. 2023. *DRAFT D3.1 – Hardware specifications and APIs of smart garments.* https://emil-xr.eu/wp-content/uploads/2024/04/D3.1-Hardware-specifications-and-APIs-of-smart-garments.pdf