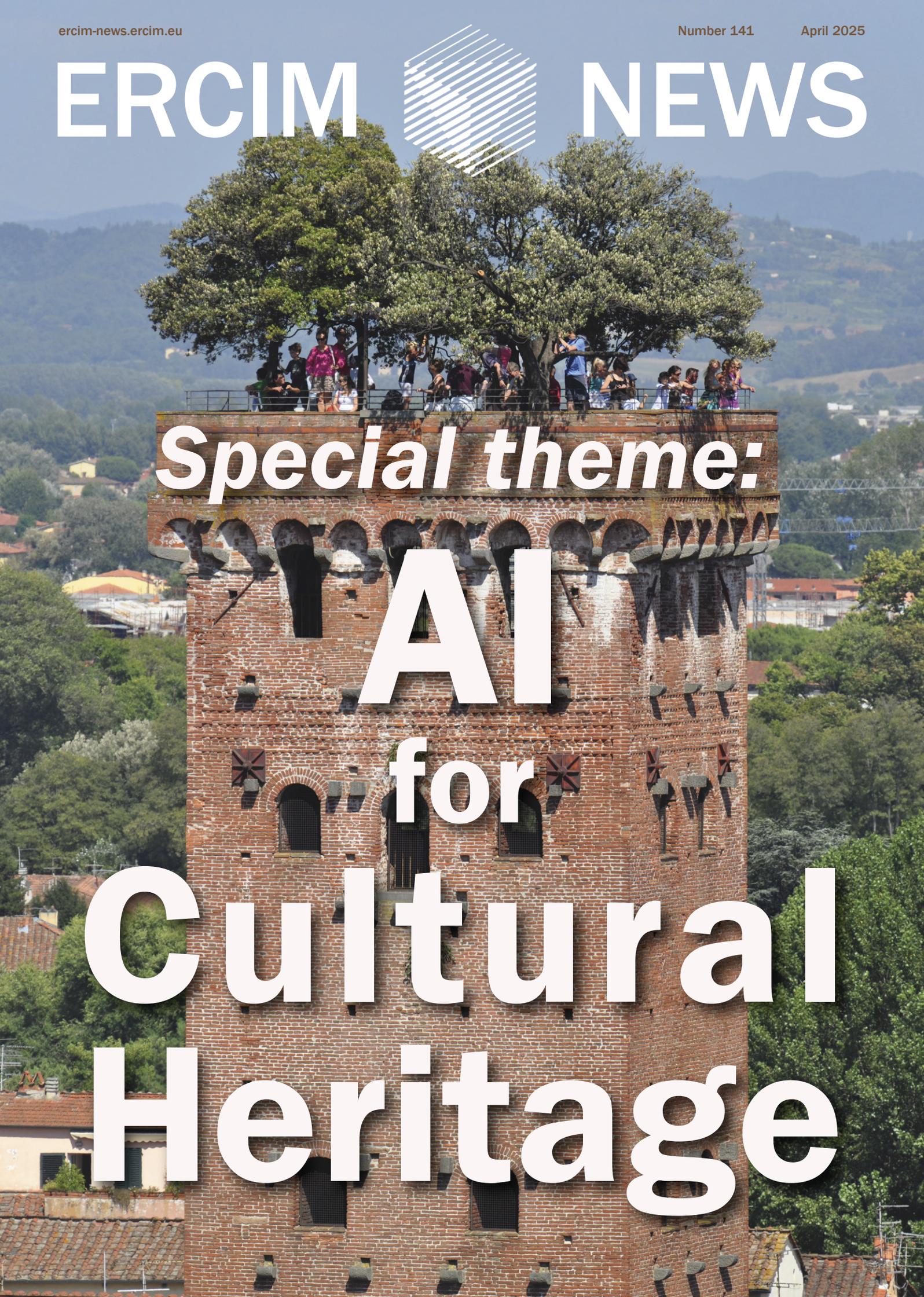


ERCIM NEWS

Special theme:

AI for Cultural Heritage



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Cover photo: View of Guinigi Tower in Lucca, Italy (source: Wikimedia). See also the article "Structural Monitoring of Heritage Buildings Via Deep Learning Algorithms" on page 13.

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ERCIM News 142, July 2025

Special theme: Swarm Computing

Call for contributions: <https://ercim-news.ercim.eu/call>

This research work is the outcome of a close collaboration between the University of Patras (Greece) and Cognitive UX GmbH (Germany), combining expertise in Mixed Reality development, AI, and user experience design. The research was partially funded by the Erasmus+ CREAMS project (Project ID: KA220-HED-E06518FA) under the call KA220-HED - Cooperation partnerships in higher education (Greek State Scholarships Foundation (IKY) [L1]).

This research was published as a demo paper [1] at the ACM User Modeling, Adaptation and Personalization (ACM UMAP) conference 2024, where it received the Best Demo Award. The positive reception underscores the project's innovation and its potential impact on interactive experiences in extended reality contexts.

Looking ahead, future work entails integrating more artwork collections and tailoring interactive features for museums and heritage sites worldwide, thereby making CulturAI a more comprehensive platform. On the technical side, the project team envisions improving speech recognition accuracy and exploring advanced user modelling to deliver personalised and adaptive interactions. Another research direction involves investigating the system's effectiveness in enhancing user engagement and retention over extended periods, potentially informing museums about how best to structure digital tours for different demographics. The team also plans to refine the suggested LLM-driven approach to create dynamic narratives that adapt to individual user models by considering the unique characteristics, preferences, and interests of the end-users. For instance, a history enthusiast might receive more detailed political context, whereas an art student might be guided through stylistic analysis and brushwork techniques.

By bridging Mixed Reality displays, real-time LLM-driven dialogue, and cultural storytelling, CulturAI demonstrates how technological innovation can expand access to the arts and transform learning experiences in museum and heritage contexts.

Link:

[L1] <https://creams-project.eu>

Reference:

[1] N. Constantinides, et al., "CulturAI: Exploring Mixed Reality Art Exhibitions with Large Language Models for Personalized Immersive Experiences", in Adjunct Proc. of the 32nd ACM Conf. on User Modeling, Adaptation and Personalization (UMAP Adjunct '24), ACM, 102–105, 2024. <https://doi.org/10.1145/3631700.3664874>

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Towards more Inclusive Museums Using AI: Guidance in Sign Language

by Dimitrios Kosmopoulos (University of Patras), Evanthia Papadopoulou (Archaeological Museum of Thessaloniki), Antonis Argyros (FORTH-ICS)

The SignGuide project has developed an interactive museum guide system for deaf and hard-of-hearing visitors using mobile devices to promote inclusion for this social group. The system is capable of understanding visitors' questions in sign language and provides additional content also in sign language using AI methods. The system has been deployed in the Archaeological Museum of Thessaloniki.

SignGuide: Making Museums Accessible for Deaf and Hard-of-Hearing Visitors

Museums are designed to educate, inspire, and preserve cultural heritage, yet for deaf and hard-of-hearing (DHH) visitors, they often remain inaccessible. Traditional museum experiences heavily rely on text-based descriptions and audio guides, which can pose challenges for those who primarily communicate in sign language rather than written language. Research has shown that many deaf individuals struggle with written content because sign language has a different grammatical structure from spoken languages, making direct translations inadequate for full comprehension [1]. As a result, DHH visitors often miss out on the depth of information available to hearing visitors, leading to an unequal experience.

The SignGuide project addresses these accessibility barriers by providing an interactive guidance system through a mobile application. Unlike conventional accessibility solutions that rely on captions or text summaries, SignGuide prioritizes sign language as the primary mode of communication, offering sign language videos and avatars to enhance engagement with museum exhibitions. This approach ensures that DHH visitors can explore exhibits autonomously, ask questions in sign language, and receive responses in their preferred communication mode.

A Real-World Use Case

Maria, a deaf visitor, enters the Archaeological Museum of Thessaloniki and notices a digital display announcing the availability of sign language guidance. She downloads the SignGuide app and is welcomed by a sign language introduction explaining how to use the app.

As she walks to the first exhibit, she notices a SignGuide logo on the display. She opens the app, points her camera at the exhibit, and within seconds, the app recognizes the artifact using augmented reality and displays a sign language video explaining its historical background [2].

Curious to learn more, Maria taps on the "Ask a Question" button. She selects a pre-recorded question in sign language asking about the exhibit's cultural significance. The app instantly retrieves a video response in sign language, providing



Figure 1: As soon as the app visually recognizes an exhibit, it can respond to user queries in sign language and retrieve related content in the same format.

her with more detailed insights (see Figure 1). Later, Maria visits another exhibit and chooses to record her own question using the front camera. The system processes her query, finds a matching pre-recorded answer, and delivers it in sign language. For the first time, Maria feels truly engaged in a museum experience, enjoying an equal level of access to information as hearing visitors.

The consortium

SignGuide was funded through the Research Create Innovate action in Greece (2020-2023), T2EDK-00982, by the consortium of the University of Patras (coordinator, sign language understanding, sign language linguistics), Foundation for Research and Technology - Hellas (human motion tracking, avatars), Bioassist SA (system integration) and the Archaeological Museum of Thessaloniki, which hosts the exhibition. The application is available on Apple Store and on Google Play [L1].

Interactive Q&A in Sign Language: One of the most innovative features of SignGuide is its interactive Q&A system, which allows visitors to ask questions in sign language and receive responses in the same format. Visitors can either:

- Select from a list of pre-recorded questions in sign language
- Record their own question using the phone's front-facing camera.

Once recorded, the app processes the visitor's query using AI-powered sign language recognition. The system tracks hand movements using a skeleton-tracking algorithm, extracts hand pose sequences, eventually extracts visual summaries and then feeds them into a Transformer-based neural network. This deep learning model matches the recorded sign language query to a set of known questions. After confirming the correct translation, the app retrieves a pre-recorded video response or generates an answer using a sign language avatar. Currently, the system supports over 300 possible questions for the most popular exhibits in the Archaeological Museum of Thessaloniki.

Impact and Reception: The SignGuide project has been warmly received by the DHH community and has been de-

signed after careful consideration of their needs. Many schools for the Deaf have visited the Archaeological Museum of Thessaloniki specifically because of this accessibility feature. For many students, it was their first fully accessible museum experience, highlighting the importance of inclusive cultural engagement. By bridging the communication gap between museums and DHH visitors, SignGuide not only enhances accessibility but also promotes a deeper appreciation of cultural heritage among underserved communities.

Future Plans: We plan to significantly upgrade the provided services by: (a) leveraging large language models and avatars to synthesize dynamically the retrieved content in sign language, (b) keeping up with the advancements in video and sequential data processing, (c) providing information before, as well after the visit, including educational content and games, and (d) involving more sign languages – currently the Greek Sign Language is supported.

Link:

[L1] <https://www.signguide.gr>

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- [2] D. Koulouris, et al., "Utilizing AR and hybrid cloud-edge platforms for improving accessibility in exhibition areas," in *Proc. IFIP Int. Conf. Artif. Intell. Appl. Innov.*, Springer, 2023, pp. 123–134.
- [3] E. G. Sartinis, E. Z. Psarakis, and D. A. Kosmopoulos, "A 3D wrist motion-based sign language video summarization technique," *Pattern Recognit. Lett.*, vol. 195, pp. 45–53, 2025.

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