

# SHIFTing to Digital: Cultural Heritage Tools for Accessibility and Appeal from the SHIFT Project

K. Valakou<sup>1</sup>, G. Margetis<sup>1</sup>, A. Spiesberger<sup>2</sup>, I. Tsangko<sup>2</sup>, D. Kounadis-Bastian<sup>3</sup>, K. Chandramouli<sup>4</sup>, I. Crucianu<sup>5</sup>, I. Crihana<sup>6</sup>, M. Milošević Micić<sup>7,8</sup>, A. Bienert<sup>9</sup>, B. Varga<sup>10</sup>, K. Klára Tvergyák<sup>11</sup>

<sup>1</sup> ICS-FORTH, Greece

<sup>2</sup> TUM University Hospital, Germany

<sup>3</sup> audEERING GmbH, Germany

<sup>4</sup> Queen Mary University of London, UK

<sup>5</sup> SIMAVI, Romania

<sup>6</sup> The National Association of Public Librarians and Libraries in Romania, Romania

<sup>7</sup> Homeland Museum of Knjazevac, Serbia,

<sup>8</sup> Balkan Museum Network, Bosnia and Herzegovina

<sup>9</sup> Staatliche Museen zu Berlin, Germany

<sup>10</sup> HNM, PCC Semmelweis Museum, Library and Archives of the History of Medicine, Hungary

<sup>11</sup> HNM PCC Hungarian National Museum, Hungary, Hungary

## Abstract.

*The SHIFT project leverages advanced digital and AI tools to enhance accessibility and engagement in cultural heritage. This poster presentation will demonstrate interactive solutions developed in the project — including haptics, text-to-speech, and AI narration — that empower institutions to create inclusive, immersive experiences for diverse audiences.*

## 1. Introduction

The SHIFT project approaches data collection and reuse in digital heritage through a conceptual framework that balances the preservation of cultural asset authenticity with the need for sustainable monetization. This process begins with high-resolution 3D and multispectral scanning, coupled with semantic metadata enrichment to capture provenance and material details, thereby creating digital surrogates that are fully traceable to their physical originals. These authenticated digital replicas are stored in a decentralized repository that combines FAIR metadata principles with a blockchain-based immutable ledger, ensuring secure authenticity certification and transparent records of custodianship. Using a modular API and microservice-based design, GLAM institutions are empowered to implement AI-assisted watermarking, dynamic licensing via smart contracts, and micro-payment systems. These enable a range of monetization models, including pay-per-view services, subscription tiers, NFT tokenization, and public-private partnership mechanisms. SHIFT's methodology blends best practices in digital curation with models from information economics and ethical valorization, incorporating hybrid techniques that combine blockchain verification, data-informed market insights, and participatory design through stakeholder workshops.

## 2. SHIFT Accessibility Framework

This project has developed an Accessibility Framework, that brings together a comprehensive suite of software tools designed to facilitate accessibility in extended reality (XR) applications through an 'Accessible by Design' approach. The framework simplifies the implementation of accessibility adaptations by offering a unified set of tools that can be easily integrated into XR development pipelines, thereby minimizing the need for disparate solutions. Specifically tailored to support users who are blind, partially sighted, or have visual impairments, the framework provides a range of customizable features, including adaptable text settings, alternative text for visual content, audio descriptions of visual elements, interactive hotspots, and multiple user control mechanisms. Additional functionalities include edge enhancement

for 3D artefacts, hierarchical scene navigation, foreground positioning of interactive objects, and visual adaptations such as brightness control, magnification lenses, and recoloring tools—each designed to address specific visual accessibility requirements. Results indicated a significant improvement in the ability of users with vision impairments to explore and interact with the virtual environment. Nonetheless, the evaluation also identified areas for refinement, which have been addressed in the final iteration of the framework to enhance performance and inclusivity further.

## 3. SHIFT Haptic Interaction tool

Haptic technology plays a pivotal role in Human-Computer Interaction (HCI) by enabling tactile engagement that enhances users' comprehension and immersion in digital environments. Within the SHIFT project, haptic interaction has been leveraged to allow users to perceive and interact with 3D digital twins of cultural heritage (CH) assets through tactile feedback. This approach transcends traditional visual and auditory modalities, offering a more inclusive and multisensory experience that is accessible to individuals regardless of their physical abilities. For users with visual impairments, haptics serves as a transformative interface, providing an unprecedented opportunity to "feel" and engage with CH artifacts previously inaccessible to them. This aligns with SHIFT's overarching objective to democratize access to cultural heritage and foster deeper user engagement. Haptic interaction also enriches the broader visitor experience by enhancing entertainment value and emotional connection with historical objects, as users can actively explore the textures, shapes, and fine details of artifacts. The development of the SHIFT Haptic Interaction Toolkit adheres to Human-Centered Design (HCD) principles, to ensure that the tool is attuned to the needs and preferences of end users. A range of commercially available haptic devices was reviewed in line with the user needs, recognizing the varying degrees of tactile fidelity, immersion, and affordability across the market. The resulting prototype includes a material-to-haptic mapping scheme that realistically simulates the physical properties of CH objects in virtual reality (VR) environments. Furthermore, the tool has been integrated into VR applications and evaluated through user testing with 20 blind and low-vision

participants, focusing on both usability and accessibility. These evaluations validate the efficacy of the tool in delivering inclusive, engaging, and meaningful interactions with cultural heritage content.

#### 4. Video & Text to Speech, Audio Narrative and Contemporary Translation Tools

The SHIFT project introduces an Affective Text-to-Speech (TTS) and soundscape synthesis system to enhance accessibility and immersion in cultural heritage (CH) experiences. The developed system converts textual descriptions — authored or AI-generated — into expressive, multilingual audio narration overlaid on silent images or videos. Supporting languages include Albanian, Hungarian, Romanian, Serbian, German, Greek, and English, with a diverse selection of native and accented voices. The solution integrates a novel Speech Emotion Recognition (SER) module for affective voice selection and incorporates an AudioGen-based algorithm for background soundscape generation. Key use cases include video dubbing, audiobook synthesis, image-to-speech, and multilingual narration, all accessible via a Python Flask API.

#### 5. SHIFT Image to Video Tool

The toolkit developed in the project supports the digital transformation of cultural heritage (CH) assets by leveraging generative AI models to animate static images, particularly paintings, into coherent motion sequences. Central to this toolkit is the application of the I2VGen-XL model, a state-of-the-art generative video synthesis framework based on stable diffusion principles. Stable diffusion models operate as latent denoising autoencoders, where noise is incrementally removed from a latent representation conditioned on an input prompt and/or image. In the I2VGen-XL pipeline, a single static image serves as the primary conditioning input, significantly reducing the reliance on large-scale text-video pair datasets. The generation process comprises two stages: a base stage, which ensures semantic consistency and temporal coherence at a lower resolution (typically 256×256), and a refinement stage, which upscales the output to high resolution (e.g., 512×512 or beyond) and corrects visual artifacts, enhancing texture fidelity and motion realism. Prompt engineering was a critical component of the implementation, with descriptive textual prompts carefully crafted to reflect the cultural and artistic characteristics of the source paintings.

#### 6. SHIFT Platform

The integrated platform architecture is designed around a data mesh concept, where data and knowledge related to cultural artefacts are organized into workspaces, each representing a distinct subdomain. These workspaces are populated either manually or using modular software tools tailored to specific business objectives. The system is implemented as a peer-to-peer (P2P) network, comprising nodes that offer services including data storage, retrieval, validation, and governance. Nodes may be added or removed dynamically, with the system ensuring automatic synchronization to maintain consistency. Full nodes operate all tools independently and expose data via APIs, while simple nodes rely on references and require access to full nodes for complete data. Tool integration relies on synchronous and asynchronous data exchanges managed through a publish/subscribe mechanism.

#### 7. Benefits of SHIFT Technologies for Libraries

The tools developed in SHIFT have aided in modernizing and expand the role of libraries as inclusive cultural hubs. By

integrating innovative tools such as AI-driven text-to-speech systems, haptic interaction interfaces, and accessibility frameworks, libraries can significantly enhance the way cultural content is delivered and experienced. These technologies support the development of personalized, interactive, and multisensory services that cater to diverse audiences, including individuals with disabilities. The presentation will explore practical applications and strategic benefits of adopting SHIFT tools to foster digital transformation and increase community engagement in the library sector.

#### 8. Inclusion in museums, Best Practices and SHIFT Tools

The application of SHIFT technologies within Homeland Museum of Knjaževac, would offer a practical insight into how different technologies have been applied to promote inclusion within museum settings. Drawing from real-world implementation, the presentation showcases best practices in adopting digital tools — such as AI-powered narration, accessibility enhancements, and interactive experiences — to engage underserved and diverse audiences. The poster presentation would highlight how these innovations are reshaping visitor interaction, improving accessibility for individuals with disabilities, and fostering more equitable participation in cultural heritage spaces.

#### 9. No one is left out! How AI-based tools can help us design an inclusive museum

The development of SHIFT tools to drive the transformative potential of AI-driven technologies in fostering inclusivity within museum environments. Focusing on visitors with disabilities, the poster presentation examines how AI can support the design of accessible, user-centered experiences — from adaptive interfaces and personalized content delivery to automated narration and navigation aids. By leveraging these tools, museums can ensure equitable access to cultural heritage, creating spaces where no visitor is left behind in the digital transformation of cultural institutions.

#### 10. Nothing about us without us – a story of empowerment

The poster presentation will emphasize the empowering role of AI-based technologies in making museums more inclusive for people with disabilities. It underscores the critical importance of involving disabled individuals throughout the design and testing phases of exhibition tools to ensure that their perspectives, needs, and experiences directly shape accessible cultural spaces. The presentation highlights how inclusive innovation not only improves accessibility but also fosters a sense of agency and belonging for all museum visitors.

#### 11. Conclusion

This poster highlights how SHIFT technologies and AI-based tools are redefining inclusivity in cultural heritage institutions. From libraries to museums, the integration of accessible design, participatory development, and adaptive digital solutions empowers institutions to reach broader and more diverse audiences. A key differentiator of our approach is the commitment to training AI on trustworthy data sourced from our own collections, prioritizing open-source language models over opaque, proprietary systems from major tech providers. Readers will gain practical insights into real-world implementations, best practices, and the transformative potential of co-creating inclusive cultural experiences — ensuring that no one is left behind in the digital cultural landscape.