Explorations into the Past: AI-Powered Virtual Reconstruction for Heritage Education

A HUMAN-CENTERED VR INSTALLATION FOR THE CENTENNIAL OF LEONTEIOS SCHOOL OF ATHENS

KYRIAKOPOULOU ANASTASIA MARIA

Architect, MSc, Researcher TUC TIE Lab, Technical University of Crete, akyriakopoulou77@gmail.com

NTZOUFRAS SOTIRIOS

Architect, PhD Candidate, Researcher TUC TIE Lab, Technical University of Crete, sntzoufras@tuc.gr

Introduction

- In celebration of the 100th anniversary of Leonteios School of Athens, **a Virtual Reality (VR)** project was developed to showcase the school's historical presence within the urban landscape.

- Virtual reality **enables an immersive exploration** of historical spaces (Radianti et al., 2020; Rodriguez et al., 2024).

- The project focuses on two emblematic school sites across two distinct historical periods:

  Fr. George Hall (1945) – originally used as children's dormitories.

  The Central Courtyard (1965) – the first outdoor basketball court in the neighborhood.

Fig. 1 *Fr. George Hall, a children's dormitory built in 1945. Left: images from the school archive. Right: screenshots from the same locations in the virtual reality application.*

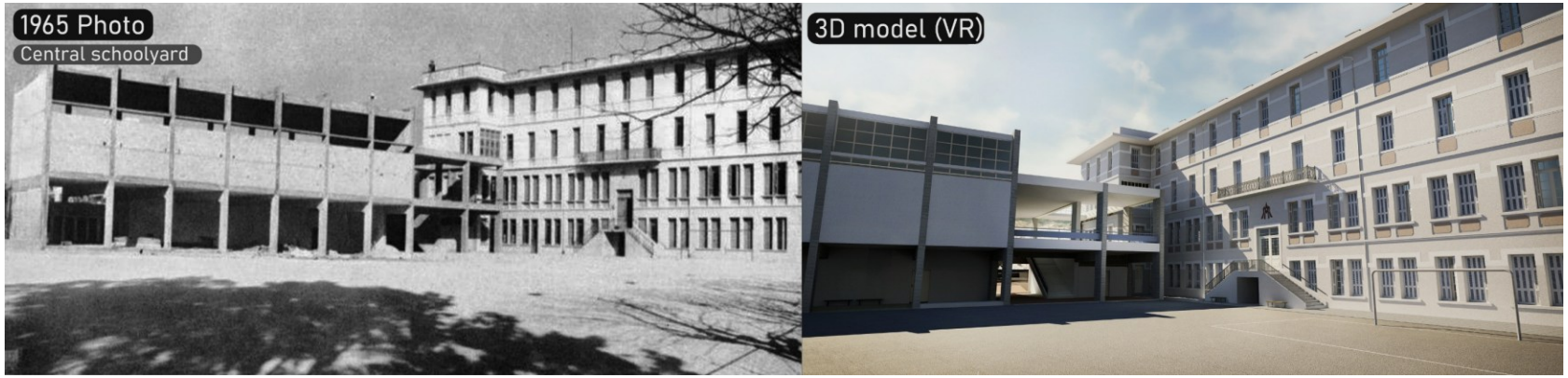
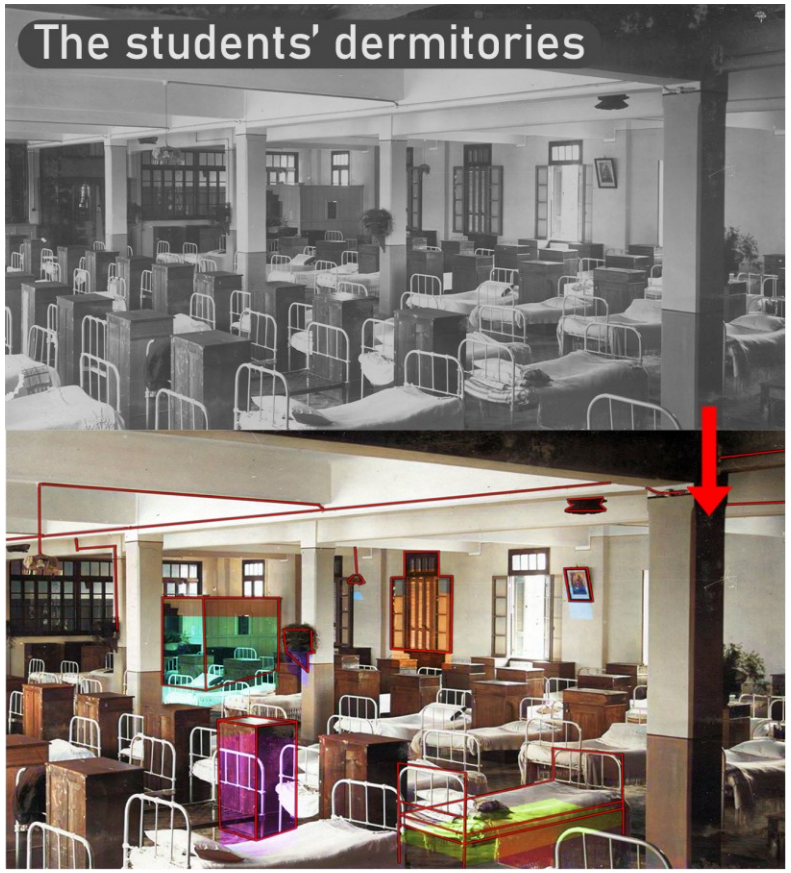


Fig. 2 *The central schoolyard, built in 1965. Left: image from the school archive. Right: screenshots from the same location in the virtual reality application.*

Methodology



AI-Based Restoration of Old Photographs and Object Detection

LiDAR 3D Scanning of Historic Furniture at the School Museum

Final Textured 3D Models from AI-Processed Photos and 3D Scanning

Fig. 3 From archive to VR: Left: AI-restored dormitory photos with object recognition. Center: LiDAR scans of historic furniture at the school museum. Right: the resulting textured 3D models.

1. **Archival Research:** *photographs, newspapers, yearbooks, and architectural drawings.*
2. **Restoration of Archival Material with AI**: *enhancement and Reconstruction of damaged photographs to extract spatial details, using carefully selected **reference images** and **targeted prompts** to avoid misinterpretations.*
3. **AI-based Optimization and Object Detection:** *image upscaling/denoising for higher resolution and object recognition (geometry, color, and material identification).*
4. **Participatory Activities:** *interviews with alumni and workshops with teachers to cross-verify information and accurately reproduce architectural details.*
5. **3D Scanning & LiDAR:** *digital documentation of museum objects (*such as *beds, nightstands, lamps) with faithful reproduction of geometry and material properties (color, texture, reflectivity).*
6. **Next Step:** *exploring AI-based 3D modeling directly from archival images and texts.*

Methodology

Fig. 4 *From archive to 3D: Left: AI-restored photos with object recognition. Center: modeling aided by 3D scanning. Right: final textured 3D model of the central schoolyard.*

VR Implementation

Fig. 5 *Final VR experience of the student dormitory: an interactive* scene with in-app menu (Reset/Restart/Exit), spatial audio and info hotspots. Assets reconstructed from AI-processed archives and 3D scans

- Developed in **Unreal Engine 5** with **real-time** lighting.
- **Spatial audio** and ambient effects (wind, sunlight variation, themed backgrounds)
- **Interactive hotspots** + in-app menu (Reset/Restart/Exit).

VR Implementation

Central schoolyard

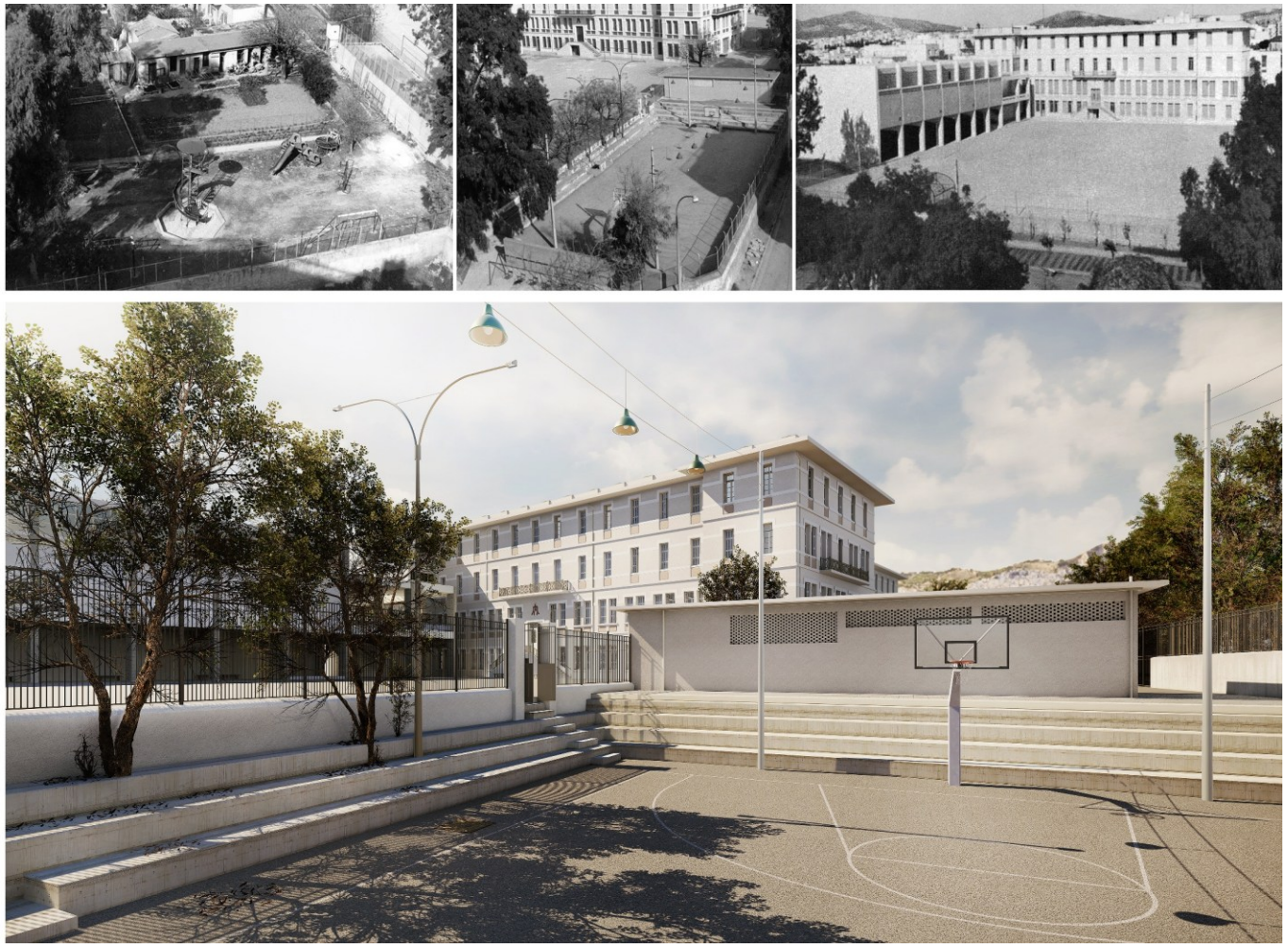


Fig. 6 *Final exterior VR environment: reconstructed central schoolyard, playground equipment, street frontage, and basketball court. Geometry and materials were derived from AI-processed archival photographs and on-site 3D scanning, with spatialized audio and information hotspots integrated in-scene.*

Deployment / Teacher Training

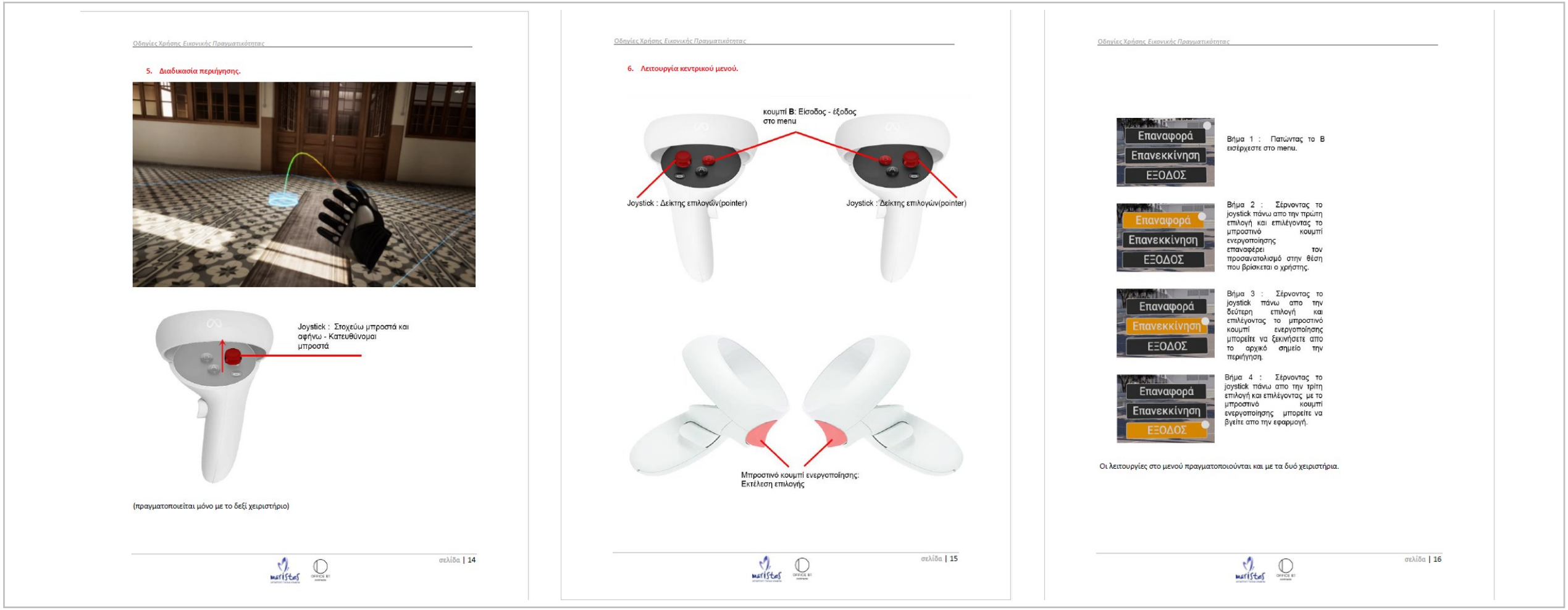


Fig. 7 Three pages from the VR Users' Manual showing: (left) teleport navigation—aim with the **right controller joystick** and release to move; (center) controller layout—**joysticks act as pointers**, **front trigger** confirms selections, **B button** opens/closes the central menu; (right) step-by-step menu workflow—**(1)** press **B** to open, **(2)** *Reset* returns to the user's current position, **(3)** *Restart* returns to the starting point, **(4)** *Exit* closes the application. Menu functions are available on **both controllers**.

- **Training sessions** with teachers were conducted to familiarize them with the VR tool.
- The school established **permanent VR stations** to showcase the project and integrated it into the technology curriculum.

Results & Impact

Fig. 8 *Students, educators, and alumni of Leonteios School of Athens explored the AI-enhanced VR reconstruction during the centennial exhibition (12 Oct 2024), providing feedback on usability and immersion.*

The digital reconstruction of historical spaces provides both **educational and cultural value**—offering the school community and the wider public an **experiential way** to engage with the school's history.

Conclusion

This project highlights the intersection of technology, education, and cultural heritage. By combining archival research, AI restoration, participatory methods, and VR, we enabled the Leonteios School community and the public to engage with history in a novel way. The installation was showcased on **October 12, 2024**, during the centennial celebration, accompanied by a VR user manual and video documentation. Beyond commemoration, this initiative **demonstrates the potential of AI-driven HCI** for **heritage preservation** and **education**.

Acknowledgements

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- *Rodriguez-Garcia, B., Guillen-Sanz, H., Checa, D. et al. A systematic review of virtual 3D reconstructions of Cultural Heritage in immersive Virtual Reality. Multimed Tools Appl **83**, 89743–89793 (2024).* https://doi.org/10.1007/s11042-024-18700-3
- *Alalaq, A. S. (2024). Reconstruction of Historical Cities Using AI Technology. SSRN. https://papers.ssrn.com/sol3/Delivery.cfm/5040088.pdf?abstractid=5040088*
- *Shih, N.-J. (2025). AI-assisted 3D preservation of Gongfan Palace. arXiv preprint. https://arxiv.org/abs/2503.10031*

Selected Publications

- ***K Magazine (Kathimerini). (2024).** Explorations into the past: A virtual reality project for the centennial of Leonteios School of Athens **[in Greek]**. K Magazine (Kathimerini). https://www.kathimerini.gr/k/k-magazine/563378494/ena-taxidi-100-chronon-gia-ti-leonteio-scholi/?fbclid=IwZXh0bgNhZW0CMTEAAR7*
- ***Archisearch. (2024).** Explorations into the past: A virtual reality project for the centennial of Leonteios School of Athens **[in Greek]**. Archisearch. https://www.archisearch.gr/videos/περιπλανήσεις-στο-παρελθόν-λεόντειο/*