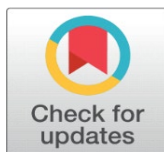
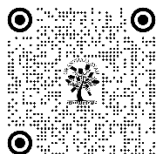


DIGITIZATION OF SHEKHAWATI MURALS USING AUGMENTED REALITY TECHNOLOGY

Priyanka Dewatwal ¹ , Dr. Nirupama Singh ² 

¹ Research Scholar, Department of Visual Arts, IIS (Deemed to be University), Jaipur, Rajasthan, India

² Professor, Department of Visual Arts, Central University, Dharamshala, Himachal Pradesh, Jaipur, Rajasthan, India



Received 15 May 2023
Accepted 03 January 2024
Published 08 January 2024

Corresponding Author

Priyanka Dewatwal,
priyanka.dewatwal@gmail.com

DOI
[10.29121/shodhkosh.v4.i2SE.2023.634](https://doi.org/10.29121/shodhkosh.v4.i2SE.2023.634)

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Copyright: © 2023 The Author(s). This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

With the license CC-BY, authors retain the copyright, allowing anyone to download, reuse, re-print, modify, distribute, and/or copy their contribution. The work must be properly attributed to its author.



ABSTRACT

This paper presents the experimental digital documentation of Shekhawati murals using an augmented reality simulation system. Augmented reality is the most influential technology of this era. All other sectors are using AR to obtain the best results in a minimum amount of time and produce outstanding products and services for the masses. This paper tells the story of augmented reality technology's intense relationship with traditional paintings in terms of creativity and showcases the experimental use of artificial reality technology to build a digital version of an open art gallery in Rajasthan. Shekhawati murals are huge and contain beautiful drawings and painting styles, unique colour palates, and incredible composition settings, all of which have the essence of our rich tradition. The digitization of the characteristics of murals and the application of artificial reality technology made this open art gallery virtually accessible for pedagogical use.

This article discusses the approach of 3D digitisation techniques in wall painting murals, including testing. The project was tested based on the requirements of Shekhawati Havili's wall paintings and their digital equivalent using an open-source technology that may be utilised for several purposes. Because the total project was created using open-source techniques, anybody can access the project to experience the Haveli paintings and their specifications.

Keywords: Wall Painting, Augmented Reality, Digitization, Shekhawati Mural, Technology, Art

1. INTRODUCTION

Augmented and virtual reality have become popular options for reconstructing and renovating old cultural heritage. [Soto-Martin et al. \(2020\)](#) These technologies provide high-quality digital three-dimensional models that can be used for education to spread awareness regarding our rich culture. Many applications are available to experience heritage sites and conduct an in-depth study of architecture from different angles. Other Android and iOS applications provide virtual tours of various heritage sites. In this context, the virtual digitization of the Shekhawati

frescos shows the composed 3D haveli, an experimental work that digitizes exquisite haveli paintings with architecture. [Challenor & Ma \(2019\)](#) This collaborative effort between fresco paintings and technology can preserve the compositions of inherent beauty while providing the benefit of using the application for multiple purposes.

This research engages users with the beautiful paintings of Shekhawati Havelis using digital tools. According to this situation, the murals are in a critical condition and are losing their original forms. The reasons behind this are climate change, ignorance, and reconstruction or renovation. These paintings are notable for their execution on massive walls and ceiling areas with unique specifications. The main concern is to conserve our rich cultural heritage using technology to see future aspects. Future research will focus on artificial intelligence, augmented reality, virtual reality, mixed reality technologies, and various tools to produce products and services for the masses. This research is an experiment to analyze frescos using open-source software such as Blender, Krita, and Artivive for generating digital forms and simulating AR websites. This study is confined to the use of the procedure on a single haveli and painted artworks. This study describes the use of open-source software to recreate Havelis and high-quality painting textures using 3D and AR technologies.

2. SHEKHAWATI MURALS

The Shekhawati Murals are stunning, intricate, culturally significant, artistic wall paintings with intriguing and distinctive subjects located in the Shekhawati region of Rajasthan. The beauty of the murals is stunning. Owing to their offbeat compositions and placement on walls, windows, balconies, steps, ceilings, and even the floors of the havelis, these frescos are famous as the open art gallery of Rajasthan. [Indian Culture. \(n.d.\)](#) These lovely havelis were constructed by the Marwari community in the area. [The Fading Frescoes and Abandoned Mansions of Shekhawati | Rajasthan. \(2021\)](#). All paintings are visible in a distinguished and stylish manner, which sets each portion of the haveli. Each panel tells the story of traditional events.

3. AUGMENTED REALITY TECHNOLOGY

Augmented reality (AR) is a computer-generated technique in which digital content can be simulated in the real world. The simulated tracking system works with perspectives and video tracking. It simulates human perception cognition in novel and exceptional ways. AR technology enables the real-world integration of digital compositions. In the current context, AR technology is widely employed in various industries such as medicine, advertising, communication, space science, and contemporary digital art. Augmented reality technology generates user-friendly services and products straightforwardly increased widely in design. [Noh et al. \(2009\)](#) The main feature of AR terminology is the simulation of digital objects in the real world using mobile, tablet, or AR glasses.

The purpose of the study is to digitize valuable paintings using a 3D platform to restore paintings from damp and flaking areas digitally. So, the complete forms of the painting can be seen properly. According to the review of the literature, many methods are available, that are costly but this paper promotes open-source tools that are free to use. Digitization of buildings has been done for decades, but what about the core paintings, which are sometimes overlooked in digital restorations? This paper aims to use three-dimensional techniques to restore traditional paintings

virtually that reveal the true beauty of history around the world. The current worldwide scenario demonstrates a lack of knowledge regarding heritage paintings in the young generation, and this research work is a little attempt to demonstrate simple existing techniques to safeguard a national resource. There have already been numerous works done on the digitization of heritage, wall paintings, and artefacts using various approaches, but the usage of open-source technologies for digitization in the context of protecting heritage is regarded as a fresh and free notion. This research is essential from the perspective of saving the digital version of the wall paintings of the havelis, which plays an important role in art history.

4. RESEARCH PROBLEM

- Shkekhawati Havelis are open art galleries and are fascinating to others on national and international platforms. Nowadays these murals are fading due to climate situations, pollution, and unawareness. [The Fading Frescoes and Abandoned Mansions of Shekhawati | Rajasthan. \(2021\)](#) Even residents of Shekhawati don't know the values of those artworks. It is not an overstatement that after some decades maybe the paintings will be lost due to ignorance.
- Murals of the Shekhawati region are known for their drawing styles and colour sense but these days people are redesigning, recolouring, and reshaping those designs according to their level of understanding. Those properties have been used by businessmen for tourism purposes for a long time. To maintain Havelis's decoration, the resorts were repainted in ordinary styles by local artists. Which is the worst part of it.
- The Shekhawati region is not a small area, it's a big area where artists drew beautiful visual narratives in a particular style but many havelis are still in bad condition and some are closed. The people who shifted to foreign countries and have properties here are not aware of that situation.

5. LITERATURE REVIEW

According to the research, art historians and conservators are striving to digitize the Ajanta Murals with photography and AI nanotechnologies that perform high-end pixel-level scanning. Digitized murals will be used for multiple purposes, including education and travel, but it will not allow visitors to enter the entire scenario. [Rooftop. \(2023\)](#) Apart from the digital preservation of the Ajanta caves, the paintings of the Badami and Allora caves are also being saved using AI robotics. On the other hand, UNESCO is deploying cutting-edge technology to preserve world heritage sites such as the Prejmer Fortified Church monument in Transylvania, Romania. [Boboc et al. \(2022\)](#) Three-dimensional reconstruction was accomplished using 3D software. Other 3D reconstruction techniques such as photogrammetry, laser scanning, lidar, Dstrech, and structural light are also used. Photogrammetry techniques generate 3D models by scanning through multiple cameras. It produces two-dimensional planes that are converted into 3D with the help of composition tools. [Fritsch & Klein \(2018\)](#) Another common technique is the laser scanning process through Microsoft Kinect, which generates a 3D model after scanning the real locations. [Bostanci et al. \(2015\)](#) Many applications can generate digital forms from photographs, and Autodesk ReCap is one such application. According to market analysis, existing techniques for 3D reconstruction and texturing are expensive. Therefore, this paper presents the initial open-source 3D and AR tools for converting frescos into immersive environments.

However, the 3D reconstruction of Shekhawati haveli to conserve fresco paintings helps the architecture and fresco paintings to be preserved. According to research, tracking systems are also being used, and users can experience the beauty of Haveli from anywhere via Artivive applications. However, the painting specification is partially exposed to comprehend the concept, inspiration, and process.

6. METHODOLOGY

This research is divided into four main phases: planning and Initialization, design and development, application of the technology to digitize the wall paintings of Shekhawati Havelis, and final product.

7. PLANNING AND INITIALIZATION

The concept of constructing a functional digital product based on research, where the integration of two extremely strong core areas can make this project distinctive for use in education and other fields. Documentation of the Shekhawati murals was performed in the initial stages to determine the actual state of the wall paintings, which helped justify the proposal. The actual condition of the havelis and wall paintings is as follows: The beautiful organic/inorganic figures and colours have vanished.

Figure 1



Figure 1 Current state of Navalghar Haveli-1

Figure 2



Figure 2 Current State of Navalghar Haveli - 2

The basic layout was created following the documentation, and the product presentation design was completed. AR technology was used in the main layout to prepare the three-dimensional composition. An open-source program was used for the AR results, and the open-source software blender was used to create 3D models of the haveli with real textures. [Blender \(n.d.\)](#) Users are required to carry a booklet of wall painting illustrations of the haveli to generate the 3D models in the real environment.

Figure 3

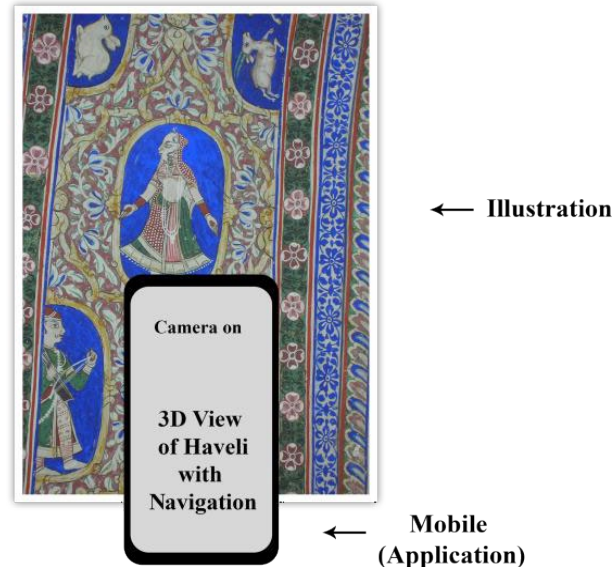


Figure 3 Illustration (Layout) of the Idea

8. DESIGN AND 3D DEVELOPMENT

Every 3D software follows the basic pipeline for achieving outstanding results, and any project must go through three major stages: pre-production, production, and post-production. The modeling and texturing section is part of the production section where the 3D reconstruction of the Navalghar haveli's core structure was modeled and textured in the project's second phase using the 3D program Blender.

3D Using modern modeling technologies, realistic architectural models that approximate the actual building were constructed. These models are separated into two parts: the first is the construction of a haveli model that faithfully reproduces its measurements, and the second is the texture of wall paintings with a similar arrangement and colour scheme. Both play significant roles in 3D composition. Despite the less precise modeling of the architecture, the paintings on the walls of the havelis were of high quality. All textures were shot from their original places before being put on UVs, which is the 3D model's orthographic projection, and all textures were applied proportionally and unstretched on UVs, as shown in the figure. The textures are placed on UVs, which essentially open flat sections of a 3D structure that are used to apply textures with raster software. Texture placement on the models is precise if the UVs are proportionate. This technique was used to texture all mural paintings on the model. Camera animation was used to navigate the area around the haveli using certain pointers that were displayed when using the application. After rendering, the sequences were edited in a blender, and sound effects were added. The completed video output will be produced for the next study.

The textures are placed on to UVs essentially opened flat sections of a 3D structure that are used to apply textures with raster software. Texture placement on models will be precise if UVs are proportionate. This technique was used to texture all of the mural paintings on the model.

Camera animation was utilised to navigate the area around the haveli with the aid of certain pointers that are displayed when using the application. After rendering, the sequences were edited in a blender, and sound effects were added. The completed video output is produced for the next work.

Figure 4



Figure 4 Model of Navalghar Haveli with Texture

9. AUGMENTED REALITY USE ON THE 3D MODEL

In this phase, the source image will be imported into the Artivive web application to map the Haveli model with the actual painting photographs. Artivive is a free artificial intelligence online programme that generates 3D navigation on models and videos in combination with augmented reality. In the following stage, compatible Blender videos or models in GLTF format will be imported into Artivive to produce the effects of augmented reality. After uploading the file, it enables the alteration feature using its editing tools to add information via text, colour correction, and navigation buttons. After that, the file is updated and overlaid with a photograph of the wall painting on the Artivive website linked to the application. While using the application from the same account, the users may scan an imported painting photograph and experience the 3D model or video in real-time by superimposing on that photograph.

10. FINAL PRODUCT (RESULT)

Users must first scan the illustration on the Artivive application to generate the final output, which they may then view on their mobile devices. While using the Artivive application, users can explore the haveli and access a variety of paintings. Artivive is an open-source programme allowing users to make and exhibit augmented reality artworks globally. By superimposing virtual elements onto the real world, users can visualise and explore the Shekhawati paintings from different

angles, zoom in to examine the intricacies of brushstrokes, and even overlay additional information or historical context about the artwork.

Figure 5



Figure 5 Application View

This study focuses on the digitization of a single Haveli painting for versatile applications. Users can scan the photograph of the painting and examine the Haveli paintings in various specific formats. Artists have embraced this web application to produce remarkable augmented reality artworks.

11. TESTING

The findings demonstrate that open-source digital platforms are user-friendly and operate perfectly. This application was shared with a group of art students for testing to confirm the study. The sample size was 20, and 8 relevant questions were asked based on the digitally generated paintings, the usage of 3D tools, AR simulation, and open-source software to acquire the figures. According to the data collection, according to the first question, 30% of students attended the open art gallery, 60% were ignorant of it, and 10% discovered it was part of their textbooks. The second question's findings reflected the usage of the digital version of the Shekhawati murals, with 90% of students finding the project easy to use and 10% finding it challenging. According to the third question, 75% of users thought the Haveli digital model was correct based on the references. The fourth question revealed that 75% of students thought the refurbished paintings looked exactly like the originals. According to the fifth question, 55% of students thought the usage of AR via open-source software made the haveli engaging and thrilling to watch, while the remaining 45% said the project should have been built as a stand-alone application. According to the sixth question, about 95% of students believed that AR made the project more engaging and that it may be utilised for educational purposes. According to the seventh question, 75% of viewers thought the photographed and digitised compositions were simulated and exhibited in three

films and a navigable haveli. According to 85% of users, the whole project is beneficial and simple to use. According to the Users, this project might be improved and expanded into a dedicated multipurpose application in the future.

The overall conclusion of the study project and article demonstrated the importance of digitising cultural material and murals for multifunctional application. There are various research techniques accessible to digitise artworks, however, open-source software can also produce good results, and the project can be used for several purposes. According to the present scenario, the future will be completely based on AR, VR, and XR, which will transform the world correspondingly.

12. CONCLUSION AND FUTURE ASPECTS

The field of augmented reality is expansive and presents numerous opportunities for development and application across various domains. According to research, several methods exist for creating augmented reality applications, but most are prohibitively expensive. In such circumstances, open-source applications and software for developing augmented reality artworks can prove to be valuable. The digitization of Shekhawati paintings is particularly advantageous for educators, art students and researchers. Art students can study the wall paintings without physically visiting the location. This research facilitates the study of the Navalghar Haveli while also imparting knowledge of open-source software workflow. The study used a sophisticated open-source simulation system for augmented reality, enabling researchers to create models for preserving national and state traditions.

The majority of researchers are currently focused on the development of Android and iOS applications. However, the innovation potential is boundless if a new application were to be created for the entire project. In the future, the digitization of the Shekhawati murals could be utilised to construct a virtual environment using VR, enabling visitors to explore the entire area through immersive virtual reality experiences. This opens up the possibility of creating a web game around Rajasthani culture and paintings, utilising three-dimensional recreations of the physical location. In addition to its gaming potential, the Rajasthan Tourism Department could leverage this application to attract tourists from around the globe, offering them the opportunity to not only observe but also actively participate in the cultural experience.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

REFERENCES

- Blender (n.d.). Home of the Blender Project—Free and Open 3D Creation Software. Retrieved From 2023, April 3.
- Boboc, R. G., Băutu, E., Gîrbacia, F., Popovici, N., & Popovici, D.-M. (2022). Augmented Reality in Cultural Heritage: An Overview of the Last Decade of Applications. *Applied Sciences*, 12(19), Article 19. <https://doi.org/10.3390/app12199859>.

- Bostanci, E., Kanwal, N., & Clark, A. F. (2015). Augmented Reality Applications for Cultural Heritage Using Kinect. *Human-Centric Computing and Information Sciences*, 5(1), 20. <https://doi.org/10.1186/s13673-015-0040-3>.
- Challenor, J., & Ma, M. (2019). A Review of Augmented Reality Applications for History Education and Heritage Visualisation. *Multimodal Technologies and Interaction*, 3(2), Article 2. <https://doi.org/10.3390/mti3020039>.
- Fritsch, D., & Klein, M. (2018). 3D Preservation of Buildings – Reconstructing the Past. *Multimedia Tools and Applications*, 77(7), 9153–9170. <https://doi.org/10.1007/s11042-017-4654-5>.
- Indian Culture. (n.d.). The Magnificent Havelis of Shekawati. Retrieved From 2023, March 22.
- Noh, Z., Sunar, M. S., & Pan, Z. (2009). A Review on Augmented Reality for Virtual Heritage System. In M. Chang, R. Kuo, Kinshuk, G.-D. Chen, & M. Hirose (Eds.), *Learning by Playing. Game-based Education System Design and Development*, 50–61. Springer. https://doi.org/10.1007/978-3-642-03364-3_7.
- Rooftop. (2023, July 18). Ajanta Cave Paintings: 5 Measures Taken in their Conservation and Restoration. Rooftop - Creative Learning Platform.
- Soto-Martin, O., Fuentes-Porto, A., & Martin-Gutierrez, J. (2020). A Digital Reconstruction of a Historical Building and Virtual Reintegration of Mural Paintings to Create an Interactive and Immersive Experience in Virtual Reality. *Applied Sciences*, 10(2), 597. <https://doi.org/10.3390/app10020597>.
- The Fading Frescoes and Abandoned Mansions of Shekhawati | Rajasthan. (2021, July 30). Design Institute in India, Arts and Design Colleges & Schools in India -IICD.