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Art Rejuvenation: Artistic Rendering in the Field of Art Restoration

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Abstract: Ancient temple sculptures from India, a cultural treasure trove, are abundant and represent the country's artistic past. But centuries have taken their toll, and many of these magnificent works of art are now broken and in poor condition. For academics, historians, and enthusiasts alike, this deterioration presents a serious obstacle to understanding and appreciating the historical and cultural relevance of these artefacts. The limits of traditional methods, which frequently fail to preserve the exquisite intricacies buried by time's relentless march, have long hampered the preservation and understanding of these works. Because of this, researchers struggle with partial interpretations and disjointed stories, unable to fully realize the potential of these amazing artefacts. Additionally, the spread of information regarding these sculptures. Art Rejuvenation gives people a virtual window into the past by utilizing cutting-edge computer vision techniques to overcome the limitations of physical degradation. Art Rejuvenation restores the original beauty of these sculptures through interactive photo analysis, illuminating their minute intricacies and offering a more profound comprehension of their cultural and historical relevance.
INDEX TERMS: Art Rejuvenation, Digital Restoration, Image-based, Dataset, Sculptures, Artistic legacy, Degradation and Deterioration, Object Detection, Computer vision techniques, etc.

I. INTRODUCTION

OVERVIEW

India's cultural heritage, rich in ancient temple sculptures, faces significant preservation challenges due to the degradation and deterioration of these artifacts over time. Traditional preservation methods often fall short of capturing the intricate details obscured by centuries of decay, resulting in incomplete understandings and fragmented narratives. Additionally, physical barriers limit access to these treasures, restricting broader appreciation and study of India's artistic legacy.

Art-Rejuvenation emerges as a transformative digital platform to address these challenges by leveraging advanced computer vision and deep learning techniques. The platform enables users to upload images of sculptures, which are then analyzed and reconstructed digitally to restore their original splendor. This digital reconstruction not only preserves the intricate details of the sculptures but also democratizes access, allowing global audiences to explore and appreciate these masterpieces Art- Rejuvenation is a two-module system comprising a sculpture information retrieval system and a reconstruction module that ensures comprehensive analysis and faithful restoration, enhancing the preservation and dissemination of India's cultural heritage.

II. PROBLEM DEFINITION

Temple sculptures are invaluable artifacts that encapsulate the rich cultural heritage and artistic prowess of ancient civilizations. Despite their historical significance, these sculptures often remain inaccessible to the general public due to physical constraints and the deteriorated condition of many of these works. This inaccessibility hinders a broader appreciation and understanding of these intricate artworks, which serve as windows into the past.

Art-Rejuvenation seeks to bridge this gap by developing an interactive web application that allows users to virtually explore and analyze temple sculptures in unprecedented detail. Utilizing advanced image analysis and deep learning, the platform can unveil hidden details and provide insights that are not easily discernible to the naked eye. Additionally, Art-Rejuvenation offers unique reconstruction options, enabling users to visualize these sculptures in various captivating styles, thereby enhancing the educational and aesthetic experience.

This project is motivated by a desire to preserve and promote cultural heritage, ensuring that the intricate beauty and historical significance of temple sculptures are not lost to time. By blending modern technology with ancient art, Art-Rejuvenation provides an engaging and accessible platform for both scholars and the general public. This innovative approach ensures that these masterpieces continue to inspire and educate future generations, fostering a deeper connection to history and culture.

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III. PROPOSED SOLUTION

To address the challenges of traditional art restoration, we propose Art Rejuvenation, a web-based application that utilizes the Stable Diffusion model for image inpainting. This application allows users to upload a damaged image along with a mask indicating the distorted regions and provide a textual prompt describing the desired reconstruction. The system then generates a high-quality reconstructed image, which can be saved for future reference or analysis.

Main Highlights:

1) Automated Restoration: Perform seamless inpainting of damaged or missing parts of images using a pretrained Stable Diffusion model.
2) User Personalization: Enable users to provide detailed textual prompts for tailored results.
3) Cloud Integration: Store the reconstructed images and associated prompts securely in an IBM Cloudant database.
4) Interactive Interface: A user-friendly interface built with Gradio ensures accessibility for individuals with varying levels of technical expertise.
5) This solution not only streamlines the restoration process but also democratizes access to advanced AI tools, making art restoration more accessible efficient.

IV. REQUIREMENTS

A. *Software*

1) IBM Cloudant: A NoSQL database used for securely storing reconstructed images and user prompts.
2) Gradio: Provides an intuitive and interactive web-based interface for users.
3) PyTorch: Facilitates GPU-accelerated computations for faster processing.
4) The Diffusers library provides the pretrained Stable Diffusion model for image inpainting.
5) Pillow (PIL) handles image manipulation tasks such as resizing, masking, and format conversion.
6) Base64 and BytesIO enable encoding and decoding of image data for storage and transmission.
7) Tempfile manages temporary file storage during image processing tasks.
8) Operating System: Windows, macOS, or Linux Python: Version 3.7 or higher.

B. *Hardware*

1) Minimum Requirements:
2) CPU: Multi-core processor (Intel i5 or AMD Ryzen equivalent) RAM: 8 GB
3) Storage: 20 GB free space
4) GPU: NVIDIA GPU with CUDA support for accelerated performance RAM: 16 GB or higher

C. *Deployment Requirements*

The application can be deployed locally or on a cloud platform for broader accessibility. Locally, the app is launched via a Python script and accessed through a web browser. On the cloud, it can be hosted on platforms like AWS, Azure, or IBM Cloud.

D. *User Requirements*

The target users of Art Rejuvenation include:

1) Art conservators seeking to restore historical artifacts.
2) Artists and designers experimenting with creative edits.
3) Educators and researchers in the field of art history.

Users require:

- A system that is easy to navigate, even without technical knowledge.
- High-quality restoration results that align with their creative inputs.
- Secure storage of their work for future reference.
- A seamless, interactive interface for uploading images and viewing results.

V. IMPLEMENTATION DETAILS

A. Module overview

Art Rejuvenation's implementation comprises three main components:

1) Cloudant Integration

- Database Configuration: IBM Cloudant is configured using Cloudant.iam(), with credentials and database URLs specified in a configuration file.
- Storage Process: Reconstructed images and associated prompts are converted to Base64 format before being stored securely in the database.
- Error Handling: The system verifies database connectivity and handles errors like invalid credentials or database unavailability.

2) Inpainting Pipeline

- Model Loading: The Stable Diffusion model for inpainting is loaded using the Diffusers library. GPU acceleration is enabled using PyTorch if available.
- Input Processing: Users upload a damaged image and a mask image. The mask indicates the regions to be inpainted.
- Output Generation: The model generates a reconstructed image based on the input and user-provided prompt. The result is displayed on the interface.

3) Gradio Interface

- Interface Design: The interface uses gr.Blocks to arrange components like image upload fields, text boxes for prompts, and output displays.
- User Interaction: Users can refine their inputs and regenerate results iteratively. The interface also displays the status of Cloudant storage operations.

B. Algorithm Details:

Reconstruction Using Stable Diffusion Model

1) Input Processing

- Accept two image inputs from the user:
  - ➢ Initial Image: A damaged or distorted image that needs restoration.
  - ➢ Mask Image: Specifies the regions of the initial image that require reconstruction.
- Accept a textual prompt that describes the desired outcome of the restoration.

2) Model Configuration

- Load the pretrained Stable Diffusion model for inpainting using the Diffusers library.
- Check for GPU availability and configure PyTorch to leverage CUDA for accelerated processing.
- Preprocess the input images:
  - ➢ Resize and normalize images to match the model's input requirements.
  - ➢ Convert images to tensors for compatibility with the Stable Diffusion model.

3) Inpainting Process

- Pass the initial image, mask image, and textual prompt to the Stable Diffusion pipeline.
- The model performs the following steps:
  - ➢ Encodes the input image into a latent representation.
  - ➢ Fuses the mask and prompt information with the latent representation.
  - ➢ Decodes the modified latent representation back into a reconstructed image.

4) Output Generation

- Postprocess the reconstructed image:
  - ➢ Convert the image from tensor format back to a standard image format (e.g., PNG or JPEG).
  - ➢ Apply any additional enhancements, such as color adjustments, if needed.
- Display the reconstructed image on the user interface.

5) Cloud Storage

- Encode the reconstructed image and the associated prompt using Base64.

- Store the encoded data in the IBM Cloudant database under a unique identifier.

6) Error Handling

- Validate user inputs (e.g., image format, prompt length) to ensure compatibility.
- Catch and handle runtime exceptions, such as GPU memory limitations or model errors, and provide informative feedback to the user.

7) User Interaction

- Allow users to refine their inputs (e.g., adjust the mask or modify the prompt) and re-run the inpainting process.
- Provide an option to download the reconstructed image or view it in full resolution.

C. Deployment Diagram

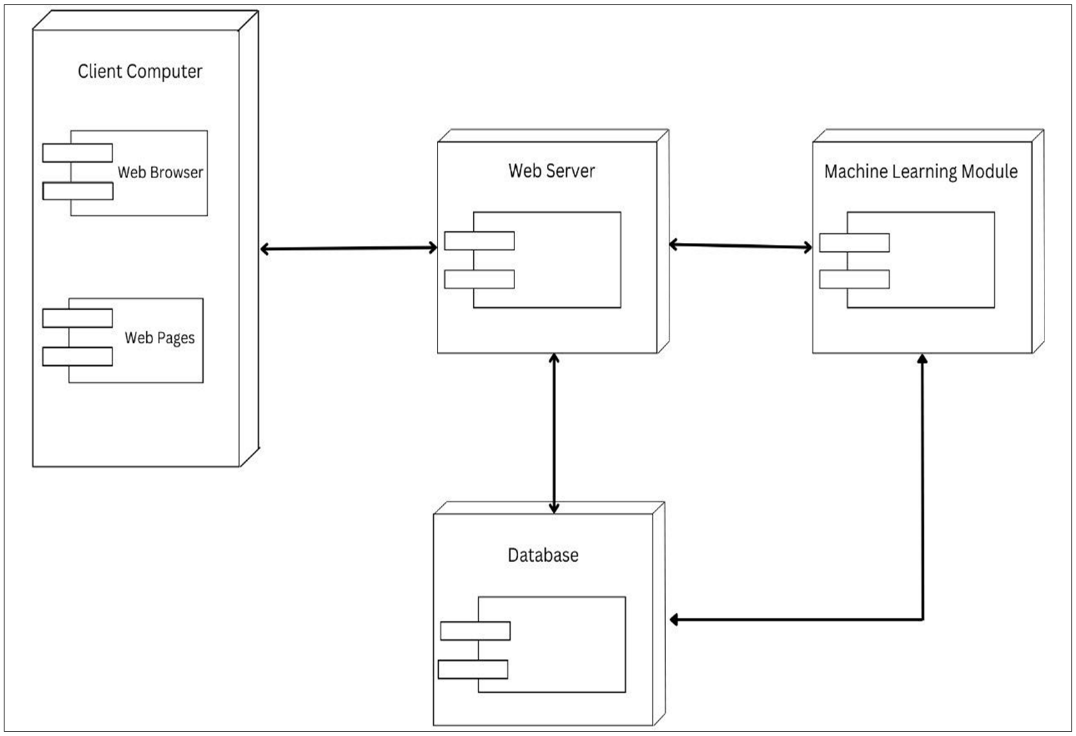

Fig. 5.1.3 Deployment Diagram

The deployment diagram showcases your sculpture reconstruction project as a web- based system. Users interact with the application from their devices using a web browser. This browser acts as a window, displaying web pages and allowing users to navigate the application's functionalities. These web pages, designed as the user interface, present options for uploading broken sculpture images, viewing reconstruction results, and potentially interacting with other features.

Behind the scenes, the web server plays a critical role. It acts as the central processing unit for the web application, handling user requests and delivering the requested web pages back to the user's browser. It also serves as a bridge between the user interface and the machine learning module.

The machine learning module, the heart of the reconstruction process, resides separately. This is where the magic happens! When the web server receives an image upload request, it relays the image data to the machine learning module. This module leverages its machine learning capabilities (like Stable Diffusion) to perform the reconstruction, essentially filling in the missing or broken areas within the uploaded image. The reconstructed image data is then sent back to the web server.

Finally, a robust database serves as the system's memory, meticulously storing all essential information. This includes user accounts and preferences, details about the sculptures, and data about the images themselves. The database might even hold information about the machine learning model itself, such as its version and performance metrics.

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In essence, the user interacts with the web application through their browser, the web server processes requests and interacts with the machine learning module, the machine learning module performs the core reconstruction, and the database stores all the crucial information for the system to function effectively. This collaborative architecture ensures a streamlined and user-centric web-based system for reconstructing broken sculptures.

1) Local Deployment
- Install the required dependencies using: pip install -r requirements.txt
- Launch the application with: python Art_rejuvenation.py
- Access the application at http://127.0.0.1:7860.

2) Cloud Deployment
- Use Docker to containerize the application for consistent deployment.
- Host the application on a cloud service like AWS, IBM Cloud, or Azure.
- Configure the domain and SSL certificate for secure public access.

VI. FUTURE SCOPE

The Art-Rejuvenation Reconstruction Model presents a promising avenue for digitally preserving sculptures, but it also has areas for future exploration and potential limitations.

1) Refinement of Reconstruction Techniques: Continuous refinement of reconstruction algorithms and techniques can enhance the accuracy and fidelity of restored sculptures. Incorporating feedback from experts in art conservation and leveraging advancements in deep learning and computer vision can further improve the reconstruction process.
2) Integration of Multi-Modal Data: Expanding the dataset to include multi-modal data such as infrared imaging, X-ray scans, and spectroscopic analysis can provide additional insights into the composition and condition of sculptures. Integrating such data with image-based restoration techniques can enhance the completeness and authenticity of reconstructions.
3) Application in Virtual Reality and Augmented Reality: Integrating the Art- Rejuvenation Reconstruction Model with VR and AR technologies can offer immersive experiences for users to explore and interact with digitally restored sculptures in virtual environments. This can facilitate education, research, and public engagement initiatives focused on cultural heritage preservation.

VII. LIMITATIONS

1) Dependency on Image Quality and Availability: The reconstruction model's effectiveness might be constrained by its quality and availability of input images. Poorly captured or low-resolution images may result in inaccurate or incomplete restorations, highlighting the importance of curated datasets and standardized imaging protocols.
2) Complexity of Sculptural Features: Sculptures with intricate details, complex textures, or unconventional materials may pose challenges for automated reconstruction algorithms. Addressing these complexities requires ongoing research to develop robust algorithms capable of accurately capturing and restoring diverse sculptural forms.
3) Ethical Considerations: The digital reconstruction of cultural artifacts raises ethical considerations regarding authenticity, ownership, and cultural representation. Careful consideration of ethical guidelines and collaboration with stakeholders such as cultural institutions and indigenous communities is essential to ensure responsible and respectful digital preservation practices.

VIII. CONCLUSION

In conclusion, the Art-Rejuvenation Reconstruction Model offers a transformative approach to digitally preserve and restore sculptures, particularly ancient temple sculptures in India. By harnessing advanced computer vision techniques and deep learning algorithms, Art-Rejuvenation transcends the limitations of traditional preservation methods, providing a virtual window into the past. Through interactive analysis of photographs, the model reconstructs the original splendor of these sculptures, enhancing our understanding of their historical and cultural significance.

Moreover, the iterative reconstruction outputs generated by the Art-Rejuvenation model showcase its flexibility and adaptability in handling diverse input scenarios. By offering multiple restoration options for each input image, the model provides nuanced interpretations of how broken parts can be reconstructed, allowing for personalized approaches to sculpture restoration.

In essence, while the Art-Rejuvenation Reconstruction Model demonstrates effective techniques for digitally preserving sculptures, ongoing refinement, and validation are essential for further improving its accuracy and usability.

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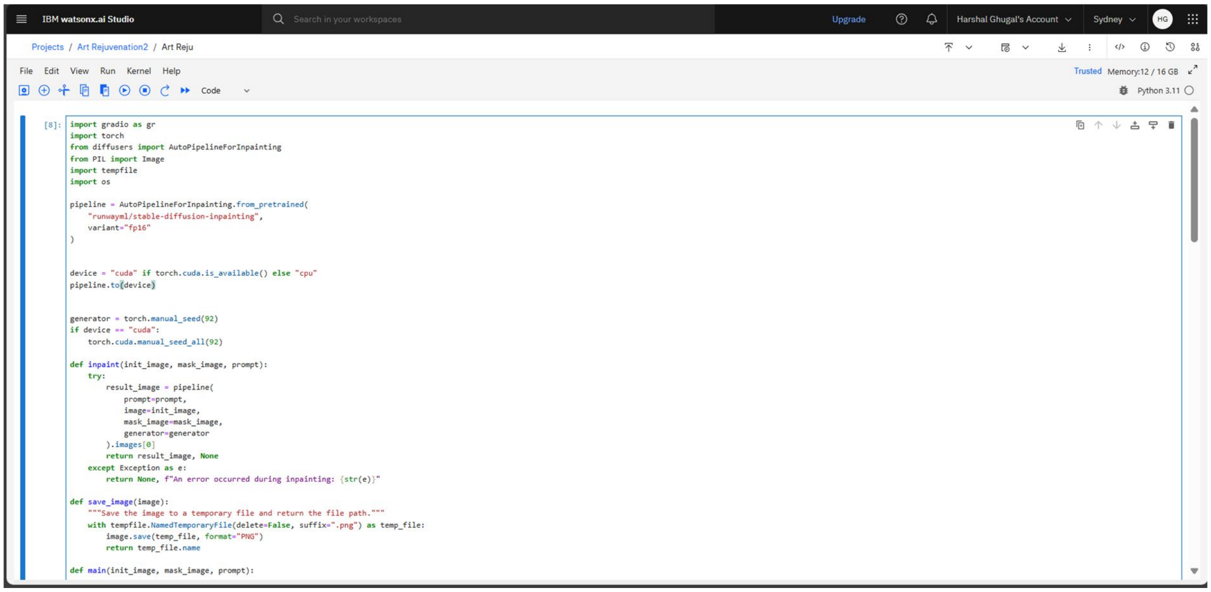
With continued optimization and user feedback, the model holds the potential to revolutionize cultural preservation efforts and ensure the accessibility and longevity of historical artifacts for future generations to appreciate and study.

IX. APPENDIX-A

Project Code:



```python
import gradio as gr
import torch
from diffusers import AutoPipelineForInpainting
from PIL import Image
import tempfile
import os

pipeline = AutoPipelineForInpainting.from_pretrained(
    "runwayml/stable-diffusion-inpainting",
    variant="fp16"
)


device = "cuda" if torch.cuda.is_available() else "cpu"
pipeline.to(device)


generator = torch.manual_seed(92)
if device == "cuda":
    torch.cuda.manual_seed_all(92)

def inpaint(init_image, mask_image, prompt):
    try:
        result_image = pipeline(
            prompt=prompt,
            image=init_image,
            mask_image=mask_image,
            generator=generator
        ).images[0]
        return result_image, None
    except Exception as e:
        return None, f"An error occurred during inpainting: {str(e)}"

def save_image(image):
    """Save the image to a temporary file and return the file path."""
    with tempfile.NamedTemporaryFile(delete=False, suffix=".png") as temp_file:
        image.save(temp_file, format="PNG")
        return temp_file.name

def main(init_image, mask_image, prompt):
```

Fig. 9.1 Code

APPENDIX-B

Screenshots of Project:

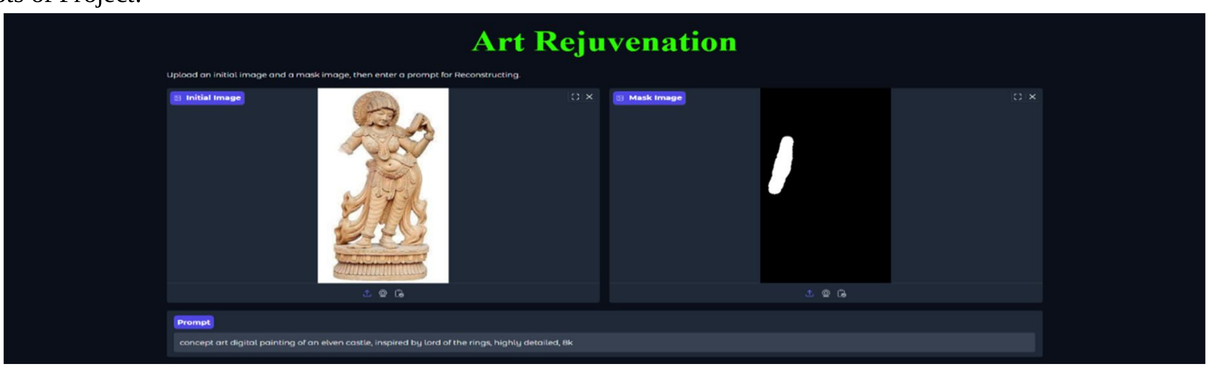


Fig. 9.1.1: Input as Distorted Image & Masked Image

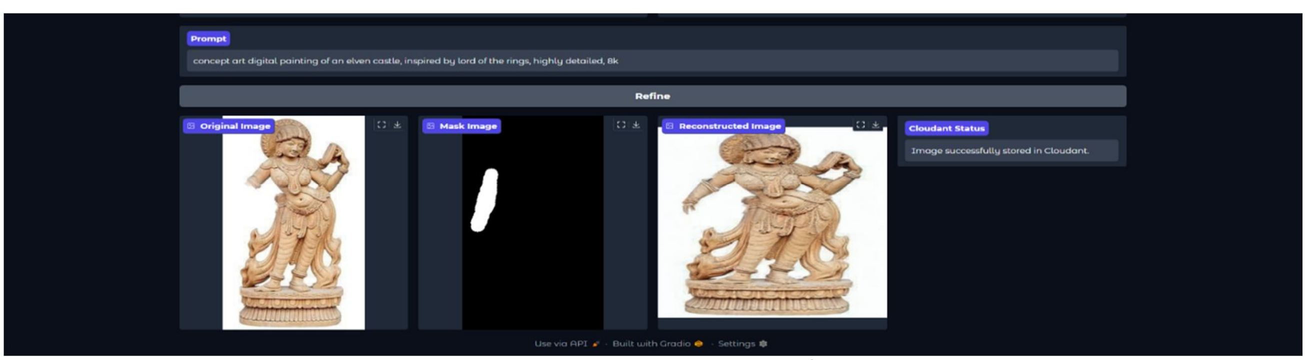


Fig. 9.1.2 Output: Reconstructed image & Status of image saved to cloud

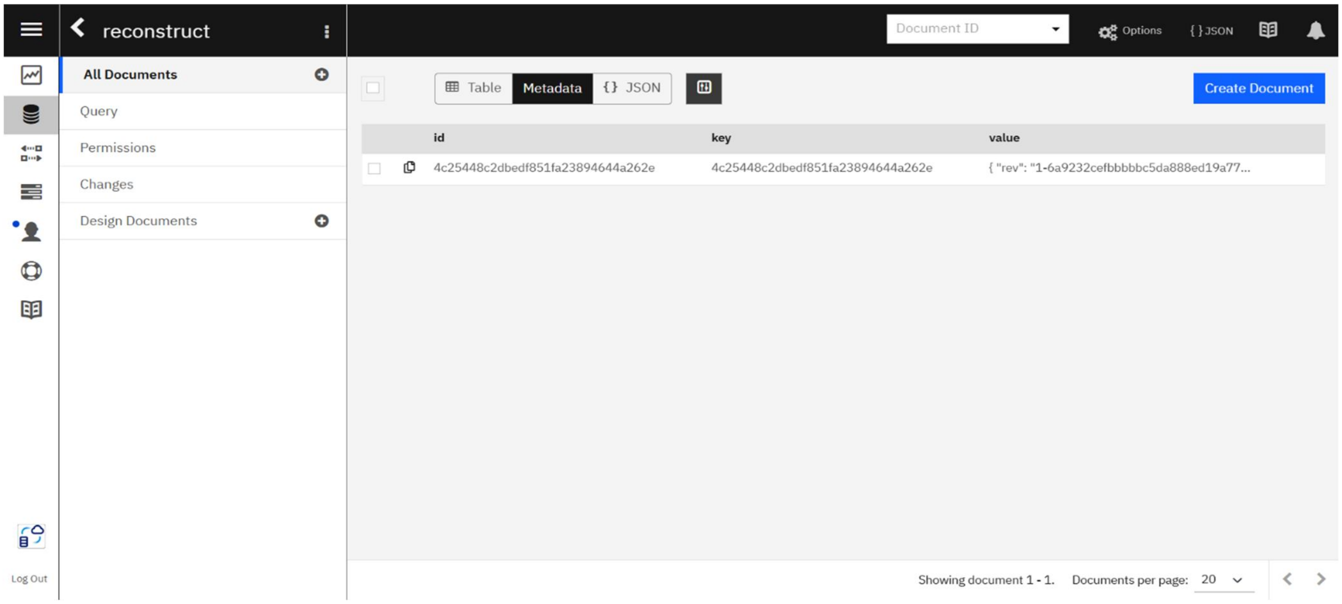


Fig. 9.1.3: IBM Cloudant Stored image in form of metadata

REFERENCES

[1] Arkaprabha Basu, Sandip Paul, Sreeya Ghosh, Swagatam Das, Bhabatosh Chanda, Chakravarthy Bhagvati, Václav Snasel, Digital Restoration of Cultural Heritage with Data-Driven Computing: A Survey published on IEEE Volume: 11.

[2] Ziyi Chang, George, 3D Reconstruction of Sculptures from Single Images via Unsupervised Domain Adaptation on Implicit Models published on, VRST ’22, Nov. 29–Dec. 1, 2022, Tsukuba, Japan.

[3] Antonio Oliveira, Ricardo Marroquin, Paulo Roma Cavalcanti, High-Quality Image Reconstruction of Point Models published a paper in IEEE Access 2020.

[4] Fazio, L. Lo Brutto, M. Gonizzi Barsanti, S. Malatesta, S.G., The Virtual Reconstruction of the Aesculapius and Hygeia Statues from the Sanctuary of Isis in Lilybaeum: Methods and Tools for Ancient Sculptures’ Enhancement. Published on Appl. Sci. 2022, 12, 3569. https://doi.org/10.3390/app12073569

[5] Ž. Santoši, M. Šokac, D. Korolija-Crkvenjakov, B. Kosec, M. Soković, I. Budak, Reconstruction of 3D models of cast sculptures using close-range photogrammetry Published on Metalurgija 2015.

[6] J Ashworth, K. Brasher, 3D reconstruction: Methods, applications, and challenges published on ResearchGate January 2013.

[7] Hanry Ham, Julian Wesley, and Hendra, Computer vision-based 3D reconstruction: A review Published in International Journal of Electrical and Computer Engineering (IJECE) August 2019.

[8] Himanshu Tanwar and Gaurav Kumar, Review Paper on Techniques of 2D to 3D Image Reconstruction published on IJRASET Journal for Research and Applied Science and Engineering Technology 2023.

[9] Preserving world-famous Ajanta Cave paintings using AI - Hindustan Times.

[10] Digital India Celebration: How AI and Deep Learning can bring ancient cultural heritage of India to life and preserve it for eternity, ET Government(indiatimes.com).

[11] Timnit Gebru, "Automated Feature Extraction for Prospection and Analysis of Monumental Earthworks from Aerial LiDAR in the Kingdom of Tonga," Journal of Archaeological Science, vol. 69, pp. 64–74, 2016.

[12] Yuval N. Harari, "Combined Detection and Segmentation of Archeological Structures from LiDAR Data Using a Deep Learning Approach," Journal of Computer Applications in Archaeology, vol. 4, no. 1, pp. 1–19, 2021. DOI:10.5334/jcaa.64.

[13] Robert Horton and Vanja Paunic, "Machine Learning Based Typology Development in Archaeology," Journal on Computing and Cultural Heritage, vol. 7, no. 1, pp. 1–23, 2014.

[14] Robert Horton and Vanja Paunic, "Learning to Look at LiDAR: The Use of R- CNN in the Automated Detection of Archaeological Objects in LiDAR Data from the Netherlands," Journal of Computer Applications in Archaeology, vol. 2, pp. 31– 40, 2019.

[15] L. Lu, H. Zhu, J. Dong, Y. Ju, and H. Zhou, "Three-dimensional reconstruction with a laser line based on image inpainting and multi-spectral photometric stereo," Sensors, vol. 21, no. 6, p. 2131, 2021.

[16] L. Chen, "Research on the application of semantic expression based on visual construction technology in oil painting teaching," Revista de la Facultad de Ingenieria, vol. 32, no. 16, pp. 144–150, 2017.

[17] S. Hu, S. Fong, L. Yang, et al., "Fast and accurate terrain image classification for ASTER remote sensing by data stream mining and evolutionary-EAC instance- learning based algorithm," Remote Sensing, vol. 13, no. 6, p. 1123, 2021.

[18] S. K. Min and J. Yoo, "Hole filling algorithm for a virtual-viewpoint image by using a modified exemplar-based inpainting," Journal of Electrical Engineering and Technology, vol. 11, no. 4, pp. 1003–1011, 2016.

[19] Y. Ran, "Application of digital image processing technology in painting art design," Revista de la Facultad de Ingenieria, vol. 32, no. 14, pp. 532–537, 2017.