Journal of Computer Science and Electrical Engineering
Print ISSN: 2663-1938
Online ISSN: 2663-1946
DOI: https://doi.org/10.61784/jcsee3142

DESIGN AND IMPLEMENTATION OF A PYTHON-BASED SYSTEM FOR NANYANG HAN DYNASTY STONE RELIEF RESOURCES RESTORATION AND VISUALIZATION

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Abstract: The Han dynasty stone reliefs in Nanyang are an important part of China's historical and cultural heritage, with high historical, artistic, and archaeological value. However, due to long-term natural weathering, environmental erosion, and human damage, many of these stone reliefs have problems like cracks, missing parts, dirt, and blurred patterns, which seriously affect their digital preservation and academic research. Currently, the management of Han painting resources generally faces issues such as scattered data, low search efficiency, and a lack of intelligent analysis tools. To address this, we designed and implemented a Python-based system for restoring and visually analyzing Nanyang Han paintings. The system uses a B/S structure, is developed with the Django framework, uses a MySQL database as a central data storage, combines Bootstrap for front-end design, and employs ECharts for multi-dimensional visual analysis. For image restoration, the system introduces a deep learning image repair model that can automatically fill in damaged areas of the stone reliefs and reconstruct patterns. For resource management, it allows adding, deleting, updating, and retrieving Han painting resource information along with categorized management. For visual analysis, it supports multi-dimensional statistical analysis like distribution by era, theme classification, excavation sites, and preservation status, and also provides word cloud analysis, combined searches, and Excel data export. Test results show that the system is stable, user-friendly, and can effectively improve the digital preservation, resource management, and academic research efficiency of the Nanyang Han dynasty stone reliefs.
Keywords: Han stone reliefs; Image restoration; Python; Django; Data visualization; Digitalization of cultural heritage

1 INTRODUCTION

Han pictorial stones are stone carvings found on Han dynasty tombs, ancestral halls, and stone towers, and they realistically reflect the political system, economic development, culture, art, and religious beliefs of the Han period. Nanyang, as an important discovery site and concentrated distribution area of Han pictorial stones, has a large number of existing Han pictorial stones, ranking among the top in the country, earning it the title of 'Hometown of Han Pictorial Stone Art.' These valuable cultural relics are not only crucial physical materials for studying Han history and culture but also an important part of China's outstanding traditional culture.

With the development of digital preservation concepts, more and more cultural heritage items are being preserved and displayed using digital technology. However, Nanyang's Han pictorial stones generally suffer varying degrees of damage over long periods of preservation. Traditional manual restoration is not only costly but also prone to introducing subjective factors. At the same time, the number of Han pictorial stone resources keeps increasing, making traditional management methods inadequate for digital management and smart analysis needs.

In recent years, deep learning technology has made significant progress in image restoration. Image restoration methods based on models like Generative Adversarial Networks (GANs)[1], Convolutional Neural Networks (CNNs), and Transformers can effectively repair damaged areas in images, improving image integrity and visual quality[2]. Meanwhile, advances in image restoration and data visualization technologies have provided new analytical tools for cultural heritage resource management[3-4]. Singhal et al. and Abed et al. reviewed existing image restoration techniques[5-6].

Based on this, this paper designs and implements a system for Nanyang Han pictorial stone resource restoration and visualization analysis that integrates image restoration, resource management, and visualization analysis, aiming to provide technical support for the digital preservation and study of Han pictorial stones.

2 SYSTEM ANALYSIS

2.1 Feasibility Analysis

2.1.1 Technical feasibility

The system uses Python as the main development language and employs the Django framework to build the web application. Python has a wealth of third-party libraries and is widely used in the fields of artificial intelligence and data analysis. Image processing is implemented using OpenCV and the deep learning framework PyTorch, while data visualization is done with the ECharts component. The database uses MySQL to store Chinese painting resources. All of these technologies are stable and mature, so the system is highly technically feasible.

2.1.2 Economic feasibility

All software platforms used in the system are open-source, including Python, Django, MySQL, OpenCV, and ECharts, so no additional software licensing fees are required. At the same time, the system has low hardware requirements and can be deployed on ordinary server environments, making it economically feasible.

2.1.3 Operational feasibility

The system uses a B/S architecture design, so users can access it through a browser without installing any additional clients. The interface is designed to be simple and user-friendly, offering a good interactive experience and meeting the needs of both general users and researchers.

2.2 Functional Requirements Analysis

Based on the practical needs of Nanyang Han pictorial stone resource management and research, the system is designed with three core functional modules: image restoration, resource management, and visualization analysis.

2.2.1 Image restoration module

The image restoration module is responsible for repairing damaged Han pictorial stone images. It supports image upload, format validation, image preprocessing, damaged region detection, and intelligent restoration. Image preprocessing includes resizing[7], denoising[8], and enhancement operations[9], while a deep learning restoration model is used to reconstruct missing textures and structural information, improving image quality and readability.

2.2.2 Han pictorial stone resource management module

This module provides full lifecycle management of Han pictorial stone resources. Users can add, edit, delete, and browse resource information, including name, era, excavation site, theme type, material, dimensions, preservation status, current location, and description. The module enables standardized storage and efficient retrieval of resource data.

2.2.3 Multi-dimensional visualization analysis module

The visualization analysis module performs statistical analysis and graphical presentation of Han pictorial stone resources. It includes era distribution analysis, theme classification analysis, excavation site analysis, and material and preservation analysis. Various charts, such as bar charts and pie charts, are employed to reveal data distribution characteristics and support academic research. In addition, the homepage provides a dashboard that summarizes key statistical indicators and visual analysis results.

3 SYSTEM DESIGN

3.1 Overall System Architecture Design

This system uses a B/S three-tier architecture, including the presentation layer, business logic layer, and data access layer. The presentation layer mainly consists of HTML, CSS, JavaScript, Bootstrap, and ECharts, and is responsible for user interaction and data display. The business logic layer is implemented based on the Django framework, handling request processing, business logic computation, and data organization. The data access layer is made up of Django ORM and a MySQL database, managing data storage and access. The overall framework diagram is shown in Figure 1.

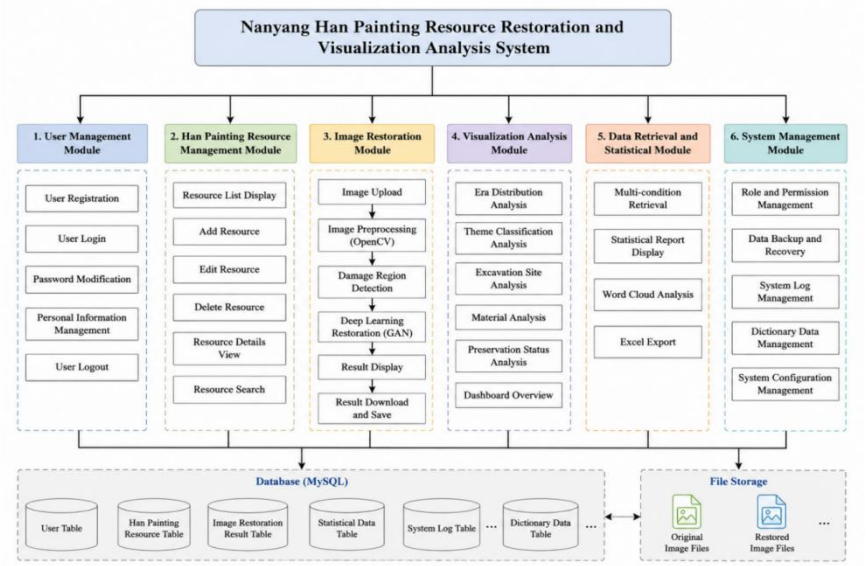

Figure 1 Function Module Diagram

3.2 Image Restoration Module Design

The image restoration module is an important part of the system, with an overall process that includes five stages: image upload, image preprocessing, defect area detection, deep learning restoration, and result display. First, users

upload the Han stone relief images that need restoration. The system uses OpenCV to normalize the image size and remove noise. Next, edge detection and threshold segmentation methods are used to extract information on the damaged areas and generate a restoration mask. During the image restoration stage, the system uses a GAN-based (Generative Adversarial Network) image restoration model. The generator restores the texture structure of the damaged areas, while the discriminator assesses the difference between the restored image and the real image, improving restoration quality through adversarial training. After restoration, the final image is output and saved on the server for users to view and download.

3.3 Han Stone Relief Resource Management Module Design

The resource management module mainly implements functions for adding, deleting, updating, and querying Han stone relief information. The system establishes a unified data standard to standardize information on names, historical periods, theme types, excavation locations, materials, and preservation status. After users input data through a form, the system uses Django ORM to write the data into the database. The resource display page presents the data in a table and provides editing and deleting functions.

3.4 Visualization Analysis Module Design

The visualization analysis module uses ECharts for data presentation. The system includes four submodules: historical period distribution analysis, theme classification analysis, excavation location analysis, and preservation status analysis. Historical period analysis uses bar charts and pie charts to show the distribution of Han stone reliefs across different historical periods; theme analysis shows the proportion of different theme categories; excavation location analysis displays the distribution of Han stone relief resources across counties in Nanyang; preservation status analysis reflects the distribution characteristics of the cultural relics' preservation quality.

3.5 Database Design

The database is implemented using MySQL and includes two core tables: the user table and the Han stone relief resource table. The user table mainly contains fields such as user ID, username, password, and registration time. The Han stone relief resource table mainly includes fields such as name, period, theme type, excavation location, material, size, preservation status, image path, and detailed description, used to store information about Han stone relief resources.

4 SYSTEM IMPLEMENTATION

4.1 Implementation of the Image Restoration Module

The image restoration module is designed to automatically repair damaged Han pictorial stone images and improve their visual integrity. The workflow includes image upload, preprocessing, damaged area detection, image restoration, and result display.

Users upload images through a web interface, and Django handles file storage and validation. OpenCV is employed to perform image preprocessing, including image resizing, denoising, and contrast enhancement. Subsequently, edge detection and threshold segmentation are used to generate restoration masks that identify damaged regions.

For image restoration, a GAN-based model is adopted. The generator reconstructs missing textures and structural details, while the discriminator evaluates the realism of restored images. Through adversarial training, the model effectively recovers damaged areas and improves visual continuity.

The restored results are stored on the server and displayed alongside the original images for comparison. Users can also download the repaired images for further research and preservation.

4.2 Implementation of the Han Painting Resource Management Module

The resource management module provides complete CRUD (Create, Read, Update, Delete) functions for Han pictorial stone resources.

Using Django ORM, the system retrieves and displays resource records in tabular form. Each record contains information such as name, era, excavation site, subject type, material, size, and preservation condition. Different colors are used to indicate preservation status for intuitive viewing.

When adding resources, users submit information through web forms, and the system validates and stores the data in the MySQL database. The editing function allows users to modify existing records, while the deletion function removes unwanted data after confirmation. These functions ensure standardized and efficient management of Han pictorial stone resources.

4.3 Implementation of the Visualization Analysis Module

The visualization analysis module utilizes ECharts to present multidimensional statistical information of Han pictorial stone resources.

The chronological distribution analysis counts resources from different historical periods and displays the results using bar charts and pie charts. Subject classification analysis visualizes the distribution of themes such as mythology, historical stories, music and dance, and daily life scenes.
The excavation site analysis compares the quantity of resources unearthed from different regions of Nanyang and supports cross-analysis between sites and historical periods. Preservation status analysis presents the distribution of resource conditions, including intact, good, average, poor, and damaged categories.
In addition, a dashboard page summarizes key indicators, providing users with an overview of resource statistics and restoration information.

4.4 Database Implementation

The system adopts MySQL as the backend database and Django ORM as the object-relational mapping framework.The User table stores user-related information, including user ID, username, password, email, and registration time. The HanPainting table stores core resource data, including name, era, subject type, excavation site, material, dimensions, preservation status, image path, restoration result path, and description.
Through Django ORM, database operations such as data insertion, query, update, and deletion can be performed efficiently without writing SQL statements directly. This design improves development efficiency, maintainability, and system scalability.
The proposed system integrates image restoration, resource management, visualization analysis, and database management into a unified platform.As shown in Figure 2. By combining deep learning-based image restoration with Django web technology and ECharts visualization, the system effectively supports the digital preservation and intelligent management of Nanyang Han pictorial stone resources. The implementation results demonstrate that the system can not only improve the quality of damaged cultural heritage images but also provide efficient tools for resource organization, statistical analysis, and academic research.

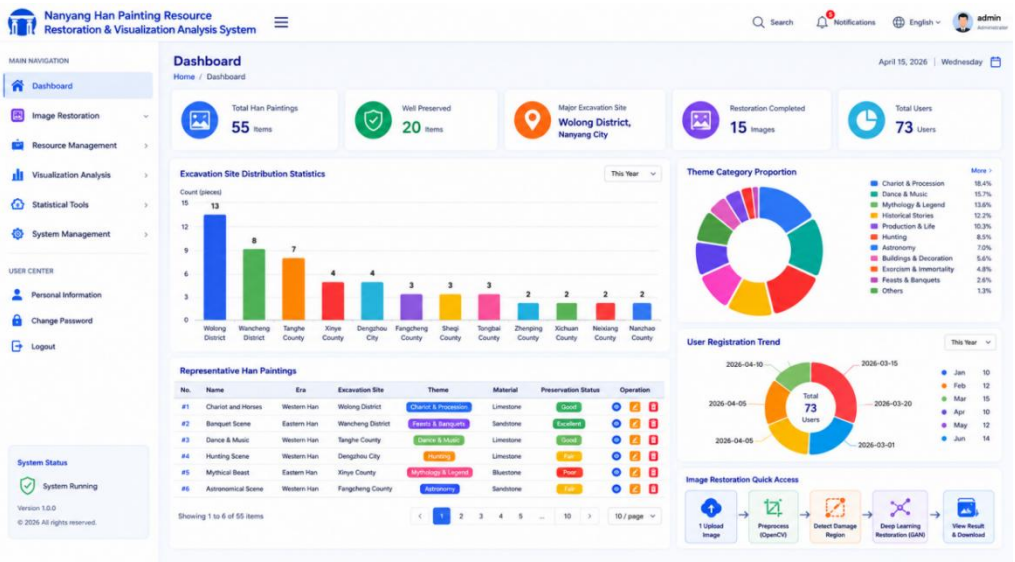

Figure 2 System Rendering

5 CONCLUSION

This article focuses on the digital protection and resource management needs of Nanyang Han dynasty stone carvings, and designs and implements a Python-based system for restoring and visualizing Nanyang Han stone carving resources. The system uses the Django framework to build a web platform, manages data with a MySQL database, combines deep learning image restoration models to automatically repair damaged areas of the Han stone carvings, and utilizes ECharts for multi-dimensional statistical analysis and visualization.
The system provides features like image restoration, resource management, visual analysis, word cloud analysis, and Excel report export, which can effectively improve the efficiency and value of managing Han stone carving digital resources. Test results show that the system runs stably and has good practicality and scalability.
In the future, transformer models, multimodal large models, and knowledge graph technology will be further introduced to improve the accuracy of the reconstruction of Han stone carvings and the capability to extract cultural knowledge, building an intelligent digital resource platform for cultural heritage protection and providing stronger technical support for the inheritance and innovative development of China's excellent traditional culture.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

The project was supported by the Nanyang City Science and Technology Plan Project (25KJGG026): Research on Key Technologies for Digital Protection and Dissemination of Han Dynasty Stone Portraits Based on Generative Adversarial Networks.

REFERENCES

[1] Yong C, Jin C, MeiFeng T. Generative Adversarial Mural Restoration Based on Multi-scale Feature and Attention Fusion. Journal of Beijing University of Aeronautics and Astronautics, 2021, 49(2): 254–264.
[2] JianFang C, Shang M, ZeYu C, et al. Mural Restoration Based on Generative Adversarial Network with Enhanced Local Attention. Computer Applications and Software, 2026, 42(10): 245–251.
[3] Zhai L, Wang Y, Cui S, et al. A comprehensive review of deep learning-based real-world image restoration. IEEE Access, 2023, 11: 21049-21067.
[4] Srivastava D. An introduction to data visualization tools and techniques in various domains. International Journal of Computer Trends and Technology, 2023, 71(4): 125-130.
[5] Singhal N, Kadam A, Kumar P, et al. Study of recent image restoration techniques: a comprehensive survey. Jordanian Journal of Computers & Information Technology, 2025, 11(2).
[6] Abed S N, Al-Jawher A M. New Trends in Image Restoration based on Artificial Intelligent Models: Analytical Study. Journal Port Science Research, 2025, 8(4): 408-423.
[7] Talebi H, Milanfar P. Learning to resize images for computer vision tasks//Proceedings of the IEEE/CVF international conference on computer vision. 2021: 497-506.
[8] Jiang B, Li J, Lu Y, et al. Eficient image denoising using deep learning: A brief survey. Information Fusion, 2025, 118: 103013.
[9] Wang W, Yin B, Li L, et al. A Low Light Image Enhancement Method Based on Dehazing Physical Model. Computer Modeling in Engineering & Sciences (CMES), 2025, 143(2).