Architecture and Implementation of an AI-Driven Digital Resource System for Art and Design Education

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Abstract. This paper proposes an AI-driven digital resource system for art and design education, aiming to improve the organization and utilization of multimodal educational resources. The system adopts a layered architecture, including resource management, intelligent processing, and functional application modules. By integrating artificial intelligence techniques such as automatic tagging, semantic analysis, and intelligent recommendation, heterogeneous resources are transformed into structured and semantically enriched data. The system supports efficient resource retrieval, accurate classification, and intelligent resource organization. The proposed method provides a scalable and intelligent solution for digital resource construction, contributing to enhanced efficiency and improved support for art and design education.

Keywords: artificial intelligence; digital resource system; art and design education; semantic analysis; recommendation system.

1 Introduction

With the rapid development of artificial intelligence technologies, digital resources have become increasingly important in art and design education[1][5]. Traditional resource management methods often suffer from issues such as inefficient retrieval, lack of semantic organization, and limited adaptability to diverse learning needs[3][6]. These challenges hinder the effective utilization of educational resources and restrict the development of students' creative abilities.

To address these limitations, this paper proposes an AI-driven digital resource system that integrates automated tagging, intelligent recommendation, and efficient retrieval mechanisms. By leveraging AI techniques, the system enhances the organization and accessibility of digital resources, thereby improving both learning efficiency and design innovation.

The main contributions of this paper are as follows:

1. An architecture for an AI-driven digital resource system is designed;
2. Key modules including intelligent tagging and recommendation are implemented;
3. Experimental results demonstrate improvements in retrieval efficiency and resource relevance.

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2 Literature Review

2.1 Digital Resource Systems in Art and Design Education

Digital resources have become a fundamental component in art and design education, providing rich materials such as images, videos, and case studies[2][4]. Existing studies mainly focus on building resource platforms to support teaching activities and enhance learning accessibility[6]. These systems improve the availability of design materials and enable more flexible learning environments.

However, most traditional digital resource systems rely on manual classification and keyword-based retrieval[3]. This often leads to low retrieval efficiency and weak semantic relevance, making it difficult for users to locate suitable resources quickly. As a result, the potential of digital resources in supporting creative design processes is not fully realized.

2.2 Application of AI in Educational Resource Management

With the advancement of artificial intelligence, AI technologies have been increasingly applied in educational resource management. Techniques such as automatic tagging, content analysis, and recommendation algorithms have shown effectiveness in improving resource organization and personalization. These methods enable systems to better understand user needs and provide more relevant content.

Despite these advancements, current research often focuses on general education scenarios, with limited attention to art and design education[7][8]. The unique characteristics of design resources, such as strong visual semantics and creativity-oriented usage, require more specialized approaches. Therefore, integrating AI techniques into digital resource systems for art and design education remains an important research direction.

3 Methodology

3.1 System Framework

This paper proposes an AI-driven digital resource system for art and design education. As shown in Fig. 1, it adopts a layered architecture (resource, data processing, core function, and application layers) to improve resource organization and utilization. The system manages multimodal resources and transforms heterogeneous data into structured, semantically enriched representations through AI-based processing, enabling efficient retrieval and intelligent services.

The overall data flow can be expressed as:

$$R \rightarrow P(R) \rightarrow F(P) \rightarrow U \tag{1}$$

where R denotes raw resources, P(R) represents processed resources, F(P) indicates functional services, and U refers to user interaction.

This layered design ensures scalability and enables efficient transformation from unstructured content to structured knowledge.

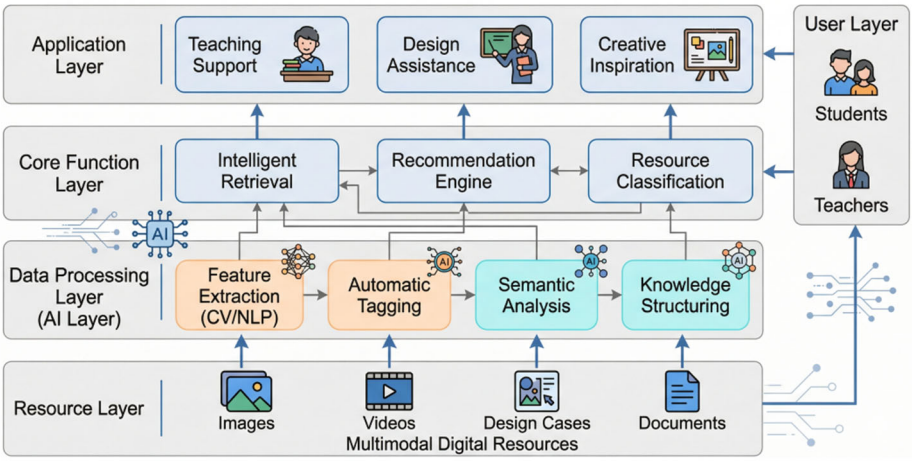

Fig. 1. AI-Driven Digital Resource System for Art and Design Education.

3.2 AI-Based Resource Processing

In the data processing layer, AI techniques are applied to analyze and structure digital resources. First, feature extraction is conducted using computer vision (CV) and natural language processing (NLP) methods. Each resource is represented as a feature vector:

$$x=[x_1,x_2,\ldots,x_n] \tag{2}$$

Based on extracted features, an automatic tagging mechanism is implemented to generate semantic labels. The tagging process can be formulated as:

$$T=f(x) \tag{3}$$

where T denotes the generated tag set and $f(x)$ represents the AI model.

Semantic analysis and knowledge structuring establish relationships among resources, forming structured representations for downstream applications. The system employs a hybrid vision-language approach: a CLIP-like model maps visual and textual data into a shared semantic space for cross-modal retrieval, while a BLIP-like module enables automatic tagging and description generation. Additionally, an aesthetic analysis component approximates design principles (e.g., contrast, balance, harmony) using computable visual features, which are integrated with semantic representations to enhance retrieval and recommendation performance.

3.3 Core Functional Modules

The core function layer consists of intelligent retrieval, recommendation, and resource classification modules. The retrieval module enables users to search resources based on semantic similarity. Given a query q and resource r, similarity is calculated as:

$$Sim(q,r)=\frac{q \cdot r}{\|q\|\|r\|} \tag{4}$$

The recommendation engine ranks resources according to relevance scores:

$$Score(r)=\alpha \cdot Sim(q,r)+\beta \cdot Pop(r) \tag{5}$$

where Pop(r) represents resource popularity, and α,β are weighting factors.

The classification module organizes resources into categories based on their semantic features, improving retrieval efficiency and system usability.

4 Experiments and Comparative Analysis

4.1 Experimental Design

To evaluate the effectiveness of the proposed AI-driven digital resource system, experiments were conducted using a multimodal dataset collected from art and design education scenarios. The dataset consists of approximately 1,200 resources, including images, videos, design cases, and textual documents, sourced from course materials, open design platforms, and publicly available digital repositories. All resources were manually verified to ensure data quality and annotation consistency.

Three methods were compared: (1) manual tagging with keyword-based retrieval, (2) text-based retrieval, and (3) the proposed AI-driven system with automatic tagging and intelligent recommendation. For each method, 100 retrieval tasks were conducted using representative design-related queries.

The evaluation metrics include response time, retrieval performance, and tagging performance. Response time is measured as the average retrieval latency per query. Retrieval performance is evaluated using Precision@10 , reflecting the proportion of relevant resources retrieved within the top results. Tagging performance is measured using Precision, Recall, and F1-score by comparing AI-generated labels with manually annotated ground truth. These metrics provide a more standardized assessment of system efficiency and effectiveness.

4.2 Performance Evaluation

The experimental results are summarized in Table 1, comparing the proposed system with the traditional method in terms of response time, retrieval performance, and tagging performance.

Table 1. Experimental Results Comparison.

Method	Response Time (s)	Precision@10	Tagging F1 (%)
Traditional Method	3.18	63.5	69.2
Proposed AI System	1.07	85.6	91.3

As shown in Table 1, the proposed system outperforms the traditional method across all metrics. The response time is reduced from 3.18 s to 1.07 s, demonstrating improved retrieval efficiency. The Precision@10 increases from 63.5% to 85.6%, indicating more effective resource matching. Meanwhile, the tagging module achieves an F1-score of 91.3%, significantly higher than the traditional approach, confirming the effectiveness of the automatic tagging mechanism. Overall, the results validate the capability of the proposed system in improving both efficiency and retrieval performance.

4.3 Module Contribution Analysis

To evaluate the contribution of each module, an ablation study is conducted by removing automatic tagging, semantic analysis, and the recommendation module.

Table 2. Ablation Study Results.

Method	Response Time (s)	Precision@10	Tagging F1 (%)
Full Model	1.07	85.6	91.3
w/o Tagging	1.45	70.2	-
w/o Semantic Analysis	1.32	74.8	88.1
w/o Recommendation	1.10	65.3	91.3

As shown in Table 2, removing any module leads to performance degradation. Without tagging, the Precision@10 drops significantly, indicating the importance of semantic descriptors. Removing semantic analysis reduces both retrieval performance and tagging F1-score, highlighting its role in capturing relationships among resources. Without the recommendation module, retrieval performance decreases notably, demonstrating its importance in ranking relevant resources.

4.4 Discussion and Analysis

The experimental results show that the proposed AI-driven digital resource system improves both efficiency and retrieval performance. By integrating automatic tagging and semantic analysis, unstructured resources are transformed into structured, searchable data, leading to faster response times and higher retrieval relevance.

The ablation study highlights the importance of each module: automatic tagging provides semantic descriptors, semantic analysis captures relationships, and the recommendation module enhances ranking. Removing any component results in noticeable performance decline, demonstrating the effectiveness of the integrated design.

Given the subjective and context-dependent nature of art and design interpretation, AI-generated tags are treated as candidate descriptors rather than definitive labels. A human-in-the-loop mechanism enables users to refine these tags, improving reliability in educational contexts.

The system is designed for practical use, with a modular structure that supports integration with tools such as Adobe Creative Cloud, Figma, and Blender, allowing users to access resources within their creative workflow.

However, this study has limitations, including a relatively small dataset and limited consideration of contextual factors such as cultural differences and creator intent. Future work will focus on expanding the dataset and enhancing context-aware capabilities.

5 Conclusion

This paper proposes an AI-driven digital resource system for art and design education, focusing on the design of a layered architecture and the integration of intelligent resource processing mechanisms. The system incorporates key techniques such as automatic tagging, semantic analysis, and recommendation to support the structured organization and efficient utilization of multimodal digital resources.

A complete framework is established, including resource management, AI-based processing, and functional application modules, enabling the transformation of heterogeneous data into semantically enriched and accessible information. The proposed approach provides a unified solution for digital resource construction and intelligent service in art and design education.

The results demonstrate that the system can effectively enhance resource management efficiency and support intelligent access to design materials. Overall, this work offers a practical and scalable method for improving digital resource systems in creative education domains. Future work will focus on extending system capabilities and incorporating more advanced AI techniques to further improve performance and adaptability.

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