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Bridging Artificial Intelligence and Shilpa Shastra for the Preservation of Indian Temple Sculptures

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Abstract

The sculptures of Indian temples is threatened by natural erosion, environmental degradation, human interference and changing practices of heritage management. Recent advances of artificial intelligence (AI) combined with computer vision, machine learning and 3D reconstruction have improved the documentation, analysis and digital restoration of cultural heritage. However, the current AI-based preservation approaches mostly rely on visual and geometric data and rarely incorporate the traditional Indian knowledge systems such as Shilpa Shastra, which define canonical proportions, iconographic features and sculptural principles. This limitation may result in technically correct reconstructions that do not fully represent the cultural, symbolic, and spiritual significance of temple sculptures.

Based on a review of AI-based heritage conservation studies and Shilpa Shastra principles, this paper proposes an AI-Shilpa Shastra Integrated Preservation Framework for Indian temple sculptures. The framework integrates AI techniques, along with computer vision and 3D reconstruction, with indigenous sculptural knowledge related to proportions, iconography, gestures, postures, and symbolic attributes. Its objective to combine ancient rule-book (Shilpa shastra) to identify damage based on cultural meaning and digitally rebuilt missing pieces an help experts make the most authentic choice for fixing temple sculptures. Expert validation by art historians, conservators, and traditional artisans is proposed to evaluate the reliability and cultural authenticity of restoration outcomes. The proposed framework provides a conceptual pathway for integrating modern computational methods with indigenous knowledge to support sustainable and culturally sensitive preservation of Indian temple sculptures.

Keywords: Artificial Intelligence, Cultural Heritage Preservation, Shilpa Shastra, Indian Temple Sculptures, Digital Restoration, Knowledge-Based Framework.

1. Research Objectives:

- To examine the limitations of existing AI-based Preservation approaches in preserving the cultural authenticity, iconography, and canonical proportions of Indian temple sculptures.



- To analyze the role of Shilpa Shastra principles in guiding the preservation and restoration of temple sculptures.
- To propose an AI-Shilpa Shastra Integrated Preservation Framework for culturally informed Preservation of Indian temple sculptures.

2. Introduction

Indian sculptures serves much more than static art, they are a sophisticated blend of **material craftsmanship, spiritual essence, and indigenous knowledge systems** that have represented the subcontinent's traditions for centuries. This *sacred presence* means that a sculpture's true authenticity is found not just in its physical shape, but in the spiritual concepts it expresses through established image-making principles. These principles are guided by traditional texts such as the Shilpa Shastra, which act as ancient manuals for artists. Within this system, three essential elements define the "identity" of a sculpture, which include **iconometry, iconography, mudra, bhava, asana, and ornaments**. These principles define the values, beliefs of temple sculptures.

According to *Kramrisch (1946)* the temple is a sacred presence and sculpture has a religious significance. *Harle (1994)* observes that the Indian temple sculptures are regulated by established **iconographic and architectural** traditions. The authenticity of these sculptures, therefore, is not just a matter of their physical form but also about their religious and cultural meanings.

However, environmental effects, biological growth, pollution, industrialization, and neglect can all be factors in the degradation of temple sculptures. These factors may result in loss of fine details, breaks and missing parts, making the restoration process more complex.

Recent developments in **Artificial Intelligence (AI)** have better cultural heritage preservation through **computer vision, machine learning, 3D scanning, and digital reconstruction**. *Tan, X. et al. (2026)* highlights two main roles for old and broken statues, the **AI detection and digital restoration** tool, while *Ma et al. (2025)* discuss the role of **3D modelling** which creates the virtual versions **and digital twins** in heritage preservation. However, existing AI approaches are good for looking "physical shape" and does not understand traditional knowledge systems that define **canonical proportions, iconographic accuracy, and symbolic meanings**.

Indian sculptural traditions follow **Shilpa Shastra principles**, along with **proportions, measurement system, iconography features (laksana), gestures and postures and symbolic attributes**. These principles have received almost no attention in current **AI-based preservation models**. *Qiu et al. (2025)* suggested that **knowledge graphs** act as a high tech bridge that allows computer to "understand" culture rather than just "seeing" shapes.

Although AI has advanced documentation and reconstruction methods, existing studies remain focused on **image analysis, digitization, and geometric reconstruction**. Limited research has explored the integration of **Shilpa Shastra principles with AI-based restoration of Indian temple sculptures**. Therefore, this study proposes an **AI-Shilpa Shastra Integrated Preservation Framework** that



combines AI techniques with traditional sculptural knowledge to support **culturally informed documentation, digital reconstruction, and preservation** of Indian temple sculptures.

3. Literature Review

3.1 Artificial Intelligence in Cultural Heritage Preservation

Artificial Intelligence (AI) has become an important technology to scan, detect and restore cultural heritage, which support in documentation, monitoring, laser scanning and digital twining through **computer vision, machine learning, deep learning and 3D reconstruction**.

Li et al. (2025) observe that while digital technologies are highly effective for documenting heritage sites, most current methods are limited because they focus almost entirely on technical data, however, these tools are excellent at capturing physical features such as 3D shapes, surface textures, measurement but they struggle with cultural interpretation. *Huang (2026)* explains that machine learning specially Convolutional Neural Networks (CNNs), support as a high -tech tool for damage detection and classification of heritage structures. Similarly, *Dagnaw et al. (2026)* discuss digital twins as excellent tools for (3D cloning) monitoring and preservation, but they lack a cultural brain.

Although AI has significantly advanced the way we document and fix heritage sites, researchers identify challenges related to limited datasets (the “learning” problem), explainability (the “why” problem), and interdisciplinary cooperation (the “teamwork” problem). *Harmanda et al. (2026)* note that AI applications has huge potential, but its current use in saving history is still in testing phase and need more input from real human experts. Therefore, current AI systems need to bridge the gap between high -tech and tradition to ensure the historical are not just repaired, but authentically preserved.

3.2 AI-Based Documentation, Damage Detection, Reconstruction, and Restoration of Temple Sculptures

AI-based technologies have indeed revolutionized the way we document and restore heritage through tools like **photogrammetry, laser scanning, and 3D reconstruction**, which allow for high-precision digital recording of archaeological objects. *Remondino and Campana (2014)* argue that digital recording techniques have significantly enhanced the way archaeological and heritage objects are documented. These technologies have transformed the field by allowing for high-precision recording and digital restoration. *Llamas et al. (2017)* demonstrated how deep learning can be used to automatically sort and classify images of architectural heritage. This means using advanced AI to look at photos of old buildings or monuments and identify what they are or what architectural style they belong to, while *Singh et al. (2025)* explored AI-based technologies have transformed the restoration of damaged sculptures; their research explored using these modern computational methods to virtually repair and reconstruct ancient artworks that have suffered from **erosion or physical breaks**. However, these existing methods mainly depend on **visual features, geometric measurements, and image data**, highlights the primary limitation of current AI technology in protecting Indian heritage. While these tools are effective at recording the physical state of a sculpture, they lack the ability to understand its deeper meaning.



According to the sources, the observation by *Ma et al. (2025)* underscores a critical tension in modern heritage preservation: while digital reconstruction tools like **3D modelling and digital twins** are vital for documenting history, they currently lack the "cultural brain" needed for true restoration.

These classical texts, including the **Manasara, Mayamata, Shilpa Prakasha, and Samarangana Sutradhara**, serve as essential "guidebooks" that have governed the creation of temple sculptures for centuries. They define the **artistic, spiritual, and cultural traditions** of the subcontinent by providing a rigorous set of rules for every aspect of a sculpture's form. Therefore, AI-based restoration may achieve geometric accuracy while lacking cultural and symbolic accuracy, this statement highlights the central "knowledge gap" in current heritage technology: while modern AI can perfectly recreate the physical form of a statue, it often fails to understand the cultural rules that give the statue its divine meaning.

3.3 Challenges in the Preservation of Indian Temple Sculptures

Saving Indian temple sculptures is complicated because these carvings are not simply old pieces of art; they are "**sacred presences**," a mix of craftsmanship and deeply held religious meaning. Unfortunately, they are affected by **pollution, climate change, and human neglect**. *Feilden (2003)* emphasizes that **climatic conditions, biological activity, and environmental exposure** contribute to the deterioration of historic structures. *Jokilehto (1999)* similarly notes the impact of **environmental changes on heritage materials**, resulting in physical deterioration.

Preservation also means identifying the right restoration approaches when **original forms, proportions, iconographic qualities, or symbolic details** have been changed or lost. Conventional conservation methods may focus on material stability while neglecting **traditional knowledge** of the original sculptural form. *Kramrisch (1946)* states that Indian sculpture follows established principles through which **spiritual and religious concepts** are communicated. Likewise, *Harle (1994)* explores the **iconographic characteristics** of Indian sculpture, including the representation of deities through their **attributes, gestures, and adornment**.

Classical texts such as *Manasara* (Acharya, 1934), *Mayamata* (Dagens, 1994), and *Shilpa Prakasha* (Boner & Saraswati, 1966) detail **measurement systems, proportions, ornamentation, and symbolic features** that guide sculptural creation. Therefore, conservation requires both **scientific methods and traditional knowledge**.

3.4 Shilpa Shastra as a Indigenous Knowledge System for Temple Sculpture

Digital technologies such as **computer vision** and **3D reconstruction** upgrade the recording and restoration of temple sculptures, although often focusing on **physical characteristics**. In contrast, *Shilpa Shastra* provides knowledge about **proportions, iconography, measurements, gestures, and aesthetics** that define the cultural identity of sculptures (Acharya, 1934; Boner & Saraswati, 1966).



- **Canonical Proportions (Pramana):** Pramana is the canonical proportion of sculptures according to traditional principles (Acharya, 1934). These **ideal proportions** are important for **aesthetic beauty, visual harmony, and symbolic meaning** (Boner & Saraswati, 1966).
- **Measurement System (Tala):** Tala is a standardized **measurement system** based on specific body and facial units. It is also **symbolic**, as different deities are assigned specific Tala classifications that support their religious and iconographic identity.
- **Iconography (Laksana):** Laksana refers to the traditional principle of **iconography** that defines identifying features of deities, including **attributes, ornaments, and symbolic elements** (Kramrisch, 1946). These features are essential for maintaining **religious meaning**.
- **Mudra and Postural Symbolism:** Mudras (symbolic gestures) and postures (asanas) represent specific **philosophical and religious meanings**. Rooted in established image-making principles (Boner & Saraswati, 1966), their preservation requires understanding beyond **physical reconstruction**.

3.5 AI, Domain Knowledge, and Research Gap

Recent work in AI emphasizes the need for **prior knowledge** to be built into computational systems. *Von Rueden et al. (2023)* emphasize that integrating **domain knowledge** is critical for improving AI reliability. In preserving Indian temple sculptures, this domain knowledge consists of **indigenous sculptural principles** found in ancient texts such as the *Shilpa Shastra*. *Hogan et al. (2021)* identify **knowledge graphs** as an effective method for organizing complex information, which is relevant for integrating **traditional wisdom into modern technology**.

However, **traditional knowledge related to Indian temple sculpture is still lacking in most AI-based restoration frameworks**. Existing AI systems primarily use **photographs, laser scanning, photogrammetry, and 3D models**, achieving high **geometric accuracy** but limited **cultural interpretation**.

Research

Gap:

AI has been successful in documenting, detecting damage and reconstructing heritage objects but there is little research on how knowledge from **Shilpa Shastra** can be represented in standard artificial intelligence systems. Concepts like **talamana, laksana, mudra, symbolic attributes and traditional restoration principles** seldom have a place in AI-based preservation frameworks. Hence, there is a need for an integrated approach to integrate AI capabilities with *Shilpa Shastra* knowledge for culturally informed and historically authentic preservation of Indian.

4. Proposed AI–Shilpa Shastra Integrated Preservation Framework

4.1 Framework Overview

Based on the view of research gap, the present work proposes an **AI–Shilpa Shastra Integrated Preservation Framework** for Indian temple sculptures. The framework integrates **Artificial Intelligence techniques** with traditional knowledge of **Shilpa Shastra** to support culturally informed and technically correct documentation, analysis and restoration.

The proposed framework includes **iconography, proportions, measurements, postures, mudras, ornaments and symbolic meanings**, which is different from existing approaches that mainly focus on visual and geometric information, to improve the authenticity of conservation decisions. Figure 1 presents the overall framework.

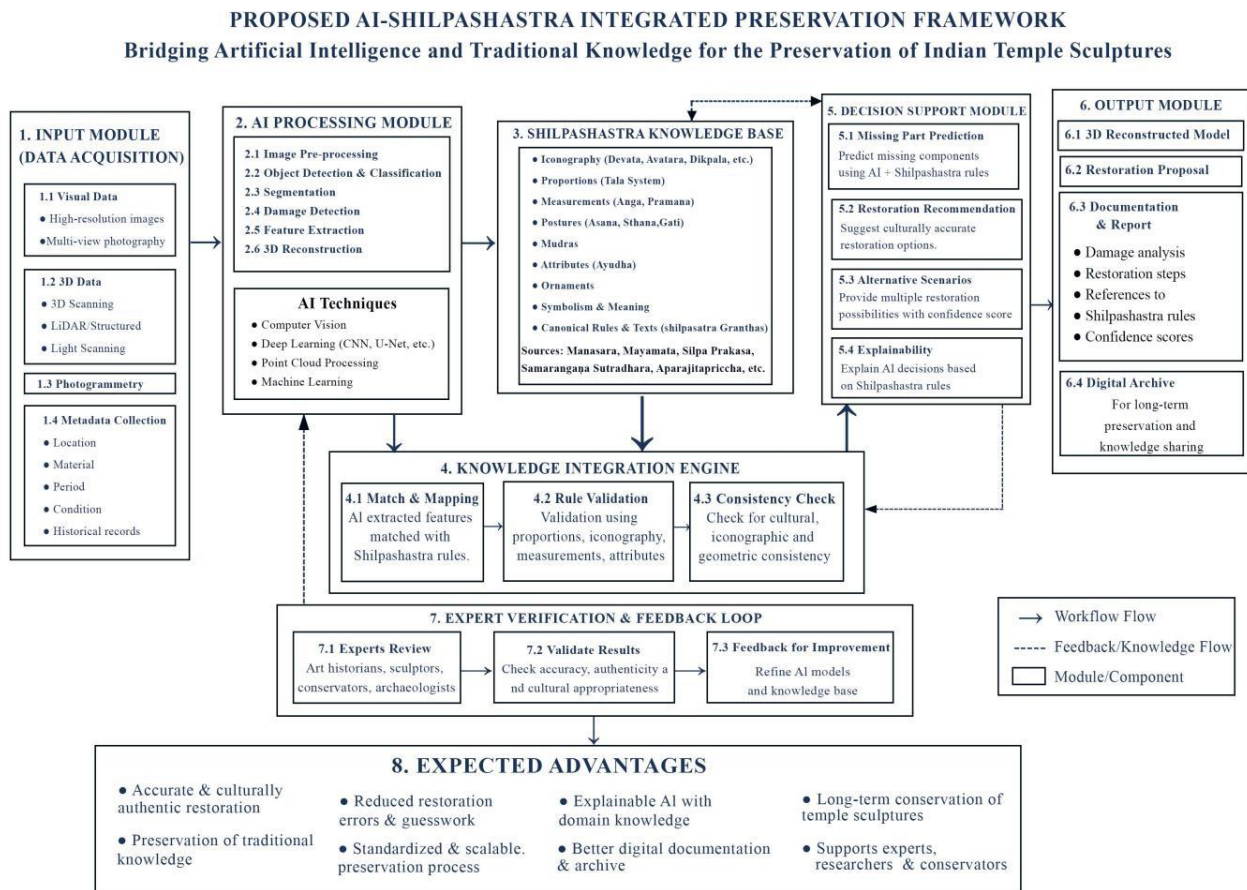


Figure 6: Proposed AI-Shilpa Shastra Integrated Preservation Framework

Figure 1: Proposed AI-Shilpa Shastra Integrated Preservation Framework

The framework starts with digital data collection of photographs and 3D scans of temple sculptures. The AI Processing Module is responsible for image processing, object detection, segmentation, damage detection, feature extraction, and 3D reconstruction. The extracted information is compared with the **Shilpa Shastra Knowledge Base**, consisting traditional principles on proportions, iconography, measurements, postures, mudras, ornaments, and symbolic attributes. The **Knowledge Integration Engine** considers geometric precision and cultural authenticity. The **Decision Support Module** provides restoration recommendations, predicts missing elements, and gives explanations of possible restoration approaches. The outputs are digital restored models, archival records and heritage protection documentation.



4.2 Framework Components

The proposed framework consists of six major components:

- 1. Input Module:** Uses photography, 3D scanning, LiDAR, photogrammetry and metadata extraction to capture digital data of temple sculpture.
- 2. AI Processing Module:** The processes collected data using **image processing, object detection, damage detection, feature extraction, image restoration, and 3D reconstruction** techniques.
- 3. Shilpa Shastra Knowledge Base:** Stores traditional sculptural knowledge derived from **Shilpa Shastra texts and traditions**, along with **canonical proportions, iconography, measurements, postures, mudras, ornaments, and symbolic meanings**.
- 4. Knowledge Integration Engine:** Matches AI-extracted features with Shilpa Shastra principles to evaluate **canonical proportions, iconographic attributes, and cultural context**, ensuring restoration decisions are both technically correct and culturally appropriate.
- 5. Decision Support Module:** Combines AI analysis and Shilpa Shastra knowledge to provide **restoration options, intervention recommendations, explanation of decisions, and evaluation of possible outcomes**.
- 6. Output Module:** Produces **digitally restored models, archival records, restoration documentation, and safeguarding resources** for long-term heritage management.

4.3 Expected Advantages

This paper proposes an **AI framework combining Shilpa Shastra knowledge** and AI technologies to assist in culturally authentic restoration of Indian temple sculptures. It helps in better restoration decision, reducing errors, conserving traditional sculptural knowledge digitally while aiding documentation and planning for long-term sustainable restoration of Indian sculptural heritage.

5. Discussion

5.1 Contribution

The proposed framework adds another layer of Shilpa shastra knowledge to existing AI conservation practices through Shilpa Shastra principles. But not aiming to replace existing methods, it adds to an established digital offering that supports interpretation and informed decisions. Current AI methods largely rely on visual and geometric data while paying little heed to traditional Indian sculptural knowledge. Thus, an artwork may have the right geometrical compositions but does not feature the **canonical proportions, pictorial representations, symbols and religious connotations** as described in Shilpashastra.



The AI-Shilpa Shastra Integrated Preservation Framework aims to safeguard India's sculptural heritage and proposes using AI in Shilpa Shastra to improve the **accuracy, authenticity and clarity of restoration decisions**.

5.2 Challenges

Numerous difficulties continue. The literature available in Sanskrit on Shilpa Shastra is to be **translated, interpreted, digitized, and organized** for use in an AI system. Moreover, standard knowledge architectures cannot be developed due to the diverse architectural and sculptural traditions of India. Thirdly, visual datasets that are related to traditional descriptions. Thirdly, there is a lack of visual datasets related to traditional descriptions.

Another major challenge in interdisciplinary cooperation between **AI developers, art historians, archaeologists, Sanskrit scholars, conservators, traditional sculptors, epigraphy**. Experts must review the restoration recommendations to ensure cultural adequacy and preservation accuracy.

The present research proposes the conceptual framework, but no **experimental implementation, expert validation, or empirical testing** has been done. Real datasets of temple sculptures or real restorations have not yet been tested. The study does not have the scope of developing detailed knowledge graphs or ontologies; the representation of Shilpa Shastra is conceptual.

5.3 Future Research

Possible future heritage systems can be built upon **knowledge graphs, ontologies, explainable AI, multimodal learning, large language models, and digital twins** to represent traditional knowledge and restoration explanations.

Future research should create knowledge bases of **Shilpa Shastra and datasets of visual and traditional knowledge for real temple cases**. This could enable AI to act as a culturally savvy system that preserves the physical form and traditional knowledge of Indian temple statues.

6. Conclusion

This study explores the application of **Artificial Intelligence (AI) and Shilpa Shastra** for the preservation and restoration of Indian temple sculptures. The research revealed a gap in AI-oriented conservation techniques whereby Indian sculptural knowledge is not incorporated in a systematic manner. Thus, the classical principles, the **iconographic rules, the proportions, the symbolic meanings**, etc. are not always observed by the existing methods.

In closing this gap, the study suggests an **AI-Shilpa Shastra Integrated Preservation Framework** that utilizes artificial intelligence in conjunction with traditional knowledge for culturally relevant documentation, analysis, and restoration. The framework consists of *pramana, tala, iconography, mudras, asanas, ornaments, and symbolic attributes*. Collaboration with **art historians, conservators, Sanskrit scholars, traditional artisans, and AI experts** will be helpful.



A key limitation of present -day AI preservation is the **lack of structured traditional knowledge**. Although the existing methods can acquire high geometrical accuracy, they cannot sufficiently capture the cultural, religious, and aesthetic principles of Indian temple sculptures. To sum up, **Shilpa Shastra and AI** alignment can open opportunities for more **authentic and explainable heritage safeguarding**.

Future research should develop **structured Shilpa Shastra knowledge, combined visual-traditional datasets , and real-world case studies** to validate the proposed framework.

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