AI-assisted Virtual Reality Digital Preservation of Sikkim Monasteries: Monastery360
A Digital Heritage Platform Proposal.

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ABSTARCT
There are more than 200 Buddhist monasteries in Sikkim, some of which date to the 1600s and 1700s, 300-400 years ago. All of them are a different story about the Buddhist culture. They are of invaluable cultural importance, yet they are under threat - literally falling apart, hard to reach, and no single, unified digital infrastructure to record them in a way that would permit anyone to access them easily. Our study presents Monastery360, a fully online solution to these problems with the help of AI and VR. The 30 research papers that we read to determine what has already been done left major gaps in the preservation of Himalayan Buddhist heritage digitally. Monastery360 is an aggregation of five key items, namely: 360 virtual tours in which individuals can immerse themselves in the monasteries, interactive maps that display the location of each monastery, AI-powered digital archives containing manuscripts and artifacts, smart audio tours that functionalize by the user being in a particular area, and a calendar of cultural events and festivals. To demonstrate technical feasibility, we tested this idea at three monasteries (Rumtek, Pemayangtse, and Enchey) and created a working frontend prototype. This project is a new strategy that is precisely aimed at Sikkim monasteries that can enhance tourism, involve the local community in the process, and enable access to these riches for education in other parts of the world.

Keywords: Digital Heritage Preservation, Sikkim Monasteries, Artificial Intelligence, Virtual Reality, Monastery360, Buddhist Architecture, Cultural Tourism

INTRODUCTION
There are over 200 Buddhist monasteries in the mountains of Sikkim and many of them are very old indeed - 300/400 years [1]. That is even older than the majority of the countries! These locations are referred to by the locals there as gompas, and they are not merely historic places, which are abandoned. They are not dormant, as Buddhist monks carry on with their own traditions and still preserve the culture [2]. The interior of any of these monasteries is fabulous - there will be old paintings all over the walls, hand crafts, centuries old manuscripts, bronze sculptures and all sorts of ritual stuff that have been in use since time immemorial [3]. The degree of workmanship is simply amazing. The larger monasteries are (where the Karmapa resides) Rumtek, (since 1705) Pemayangtse and Enchey. Their styles are different and each of them belongs to various traditions of Buddhism [5]. However, the thing is that here they are under threat. There are always risks of earthquakes in that area, climate change complicates everything, and there are more extreme monsoons every year, and many of them are so remote that it is extremely hard to reach them [6][7].

Of course there have been others who have made attempts to help. They have also recovered murals, scanned some manuscripts, yet there is no one single location where you can locate all the details about all the monasteries in Sikkim [10]. This brings about a host of problems. These cultural treasures are not getting documented in a proper manner, tourism is not doing what it can do, researchers cannot find what they are seeking in a single location, local communities are not truly engaged in the preservation efforts and people world over are not able to experience the spaces without having to travel there [11]-[15].

Research Area
So what is the position of our research? It is literally an amalgamation of disciplines. I am dealing with digital heritage preservation - that is the principal point. However, we are also exploring computer science such as AI and VR, cultural heritage research, tourism technology, and information systems.

We are primarily seeking a method to make modern technology assist in preserving and spreading these holy sites in the Himalayas to all.

Research Question

What are we really building? We're building a product called Monastery360 - an AI and VR digital product applied to the Buddhist monasteries in Sikkim. It is much bigger than creating a site or an application. Our vision is to create an entire system which will help to combine intelligent archiving, virtual reality and experience that you are there actually and interactive opportunities that would be designed to specifically suit these monasteries and people who would be interested in learning about them.

Research Questions

In this project, we continued to pose ourselves four major questions: First, what digital practices have been effective in preserving Buddhist sites in other places? Second, what are the precise issues that the monasteries of Sikkim are struggling with and how can we come up with features that address those particular issues? Third, what do we do to ensure that AI and VR co-exist in the same platform? And fourth, what is a realistic roadmap of actually making this come to pass and operate in the long run? Since, frankly speaking, what is the use of a year and then being dead? II.

LITERATURE REVIEW

Digital Heritage Preservation.

The importance of digital heritage preservation has gained a lot of relevance as a discipline that has integrated cultural conservation and computer science [20]. The Charter on Digital Heritage by UNESCO was the first step towards the realization that digital documentation is not merely a nice thing to have, but rather the key to continuing culture [21]. Such organizations as CyArk have been making a commendable effort, documenting more than 200 heritages worldwide with laser scanning and photogrammetry. This has Buddhist monuments in such locations as Bagan, Myanmar [22][23]. Interestingly enough, it has been discovered that we are required to record things before actual disasters occur rather than after [6]. Research investigating the issue of digitally restoring destroyed heritage sites indicates that we are becoming increasingly proficient at such a task - integrating photogrammetry, laser scanning, and AI algorithms in order to bring damaged places back to life, at least in digital form [7][8][9].

VR in Cultural Heritage.

VR has been sincere to revolutionize the game as far as the experience of cultural heritage is concerned [1]. You do not simply see pictures and read about places, but you get to experience the feeling that you are there. This is supported by research - according to studies, heritage websites using VR applications make people learn more and get to know more about the culture than by more traditional methods [4]. Consider the case of the Ajanta Caves VR. It allows individuals all over the world to explore these Buddhist caves virtually, which is a good thing since it implies that the physical caves will not be destroyed by the excessive number of visitors [1]. Secondly, there is a fascinating project being run on metaverse applications of Buddhist monuments, essentially the creation of permanent virtual environments in which these heritage sites can be found online [2]. Kodaiji Temple projects in Japan and Shwedagon Pagoda in Myanmar demonstrate alternative modes of accessing sacred spaces of Buddhism to the virtual reality [5]. The good thing is that now we have AR, VR, and MR (mixed reality) to choose, and can therefore select the appropriate strategy to follow based on what we are trying to accomplish and to whom we are trying to reach [21][4].

Heritage Conservation Artificial Intelligence.

The AI application in cultural heritage provides features beyond the human pattern recognition in tasks of documentation and analysis [11]. The machine learning programs prove to be effective in the analysis of images, categorizing artifacts, identifying deterioration, and predictive conservation [14].

With the help of Convolutional Neural Networks, cultural heritage imagery is classified according to artistic styles and authenticated works of art [12][14]. Artificial intelligence-driven damage recognition uses images to detect the patterns of damage such as cracks, discolouration, and structural issues [15]. With the aid of Natural Language Processing and OCR, it is possible to do the digitization of manuscripts, and a study of Tibetan text recognition indicates that the translation of classical scripts is improving [12][25].

Neural Radiance Fields of the types are new methods of 3D reconstruction of 2D images, producing models of photorealistic objects using collections of photographs [17]. Predictive conservation applications predict the risk of deterioration using the data of environmental monitoring [18][19].

Documentation Technologies (3D)

The 3D documentation technologies are the sources of underlying data to be analyzed by AI and presented in VR [6]. Terrestrial Laser Scanning is used to record finer point clouds in the level of millimeters [26]. Photogrammetry uses overlapping photos to develop 3D models and the UAV-based methodology allows mapping of places of inaccessibility [9][29].

Light scanning Structured light scanning resolves features on artifacts and sculptures under a millimeter [26]. Multi spectral imaging is a process that shows information the naked eye could not see as it goes outside the visible wavelengths which shows other details hidden in the Buddhist murals [1][12][24].

Buddhist Heritage Initiatives

The cultural heritage site of Buddhism has its own preservation challenges both in the religious sensitivity and conservation imperatives [24]. The destruction of the Bamiyan Buddhas triggered the international media focus on the prevention of digital documentation [27]. The single article on the topic of cloned Buddhas discusses the potential of 3D scanning, as it relates to Buddhist heritage, how this technology would influence the concepts of authenticity and religious values [24].

Research Gap

Nevertheless, there are still key gaps in the literature: a lack of integration of AI and VR into complex systems of Himalayan Buddhist monasteries; no consideration of sacred space ethics digitization; no sustainability models in the context of the region; no single platform to focus on tourism, preservation, and education at the same time [16][22][23].

Proposed Solution Monastery360 Platform.

Platform Overview

Monastery360 is suggested to be a total digital heritage platform that specifically projects onto the Buddhist monasteries of Sikkim. The platform covers the gaps identified by bringing together preservation, accessibility, tourism and education in a single ecosystem. Monastery360 as opposed to the current scattered strategies offers one gateway to multiple stakeholders such as tourists, researchers, educators and communities.

KEY FEATURE

Virtual Tours Module

The site contains 360-degree panoramic shots of the interior and exterior of monasteries and landscapes around them. Immersive virtual tours help visitors to explore religious sites remotely where they can listen to a narration in various languages such as English, Hindi, Nepali, and Tibetan [1][4]. Hotspots are also interactive and give more information about architectural features, murals, sculptures, and ritual objects the user can find during virtual tours [2][5].

Interactive Map Module

Geo-tagged sites of monasteries appear on interactive maps of travel routes that can be customized, as well as attractions near them [9]. Connection to local transport and tourism facilities aid the visitors to plan extensive visits to the monasteries. Filter options allow the users to search by age of the monastery, lineage affiliation, building style or featured artifacts.

Digital Archives Module

Digital archives that are searchable now exist with scanned manuscripts, photos of murals, and historical records [12][25]. The AI-based sorting is used to automatically label content based on subject, time, artistic style, and religious merit [11][14]. The enhanced search functionality allows the researchers to find particular iconographic elements, textual citation, or methods of art in the entire archive.

Smart Audio Guide Module

Location-based audio guides are based on GPS navigation, which provides contextual information during the search of physical monastery locations by visitors [4]. The integration of Bluetooth beacons offers an accurate indoor location to narrate room by room. Offline mode will be used when the connection is weak in the isolated regions and the content can be downloaded in advance and used during the visits.

Cultural Calendar Module

Today, detailed programs of events, festivals, and rituals of monasteries inform the visitors about ceremony activities [2]. Reservation and attendance services allow tourists to enter special occasions where the right protocols are applied. Alarm functions remind interested followers of an impending important event.

Conceptual Framework

Monastery360 uses five layers that are interconnected:

Data Acquisition Layer: Gathers monastery data using 360deg photography, photogrammetry, document scan and metadata by adhering to the accepted heritage documentation guidelines [6][29].

AI Processing Layer: Uses machine learning to enhance images, classify artifacts, read text, and semantically tag images [11][14][17].

Storage Layer: Stores well-organized digital repositories, with the correct metadata, access control, and backup mechanisms [19][21].

Presentation Layer: Provides content on web interfaces, mobile applications, and VR experiences tailored to various devices and application contexts [4][5].

Local participation in content creation, verification and cultural interpretation: Community Layer allows local involvement in the creation of content, content verification, and cultural interpretation [22][23].

METHODOLOGY

Research Design

The research presented in this study is a mixed-methods research using systematic literature review as well as design science research methodology. The literature review consists of synthesizing knowledge presented by 30 academic resources exploring the digital heritage preservation, AI-use, and VR technologies. Monastery360 platform conceptualization and prototype development is guided by design science methodology [30].

Literature Review Process

Relevant publications were found in the systematical search of scholarly databases (IEEE Xplore, ACM Digital Library, ScienceDirect, Google Scholar) using such keywords as digital heritage preservation, virtual reality monastery, AI cultural heritage, Buddhist heritage digitization, and 3D scanning temple. The selection criteria focused on peer-reviewed publications of 2014-2025, which covered technologies that could be applied to religious heritage sites.

Solution Design Process

The features of the platform were based on literature-defined best practices that were aligned with the needs of Sikkim monasteries. Unique Monastery360 characteristics were informed by a gap analysis between the current solutions and the local needs. The design development was refined through the iterative process using the views of heritage preservation principles and tourism development [16][19].

Prototype Development

Frontend prototype development was done to test user interface and technical viability. The modern web technologies used in development allowed using a responsive design, interactive mapping, and immersive content presentation. Prototype shows the main features of the user experience, such as navigation in the virtual tour, browsing the archives, and interactive map.

Case Study Framework

Three monasteries were chosen that characterizes Monastery360 usage that depict the following features: Rumtek (large, modern, institutional headquarters), Pemayangtse (historical, traditional architecture), and Enchey (smaller, active ceremonial life). Case frameworks contain detailed documentation requirements and anticipated platform benefits per site.

CASE STUDIES

Rumtek Monastery

Rumtek Monastery, the largest Sikhs monastery used as the headquarters of Karma Kagyu lineage. Constructed in the 1960s as a recreation of the Tsurphu Monastery in Tibet the complex covers about 3 hectares including the central monastery, monastic college, retreat center, and housing.Documentation Requirement: 360deg coverage of four-story main building fulfilled; a detailed record of the 25-foot statue of Buddha and the murals around it; an archives of thangka collection and ritual gear; a record of daily prayer sessions.

Application Platform: Virtual tours enable Karma Kagyu practitioners around the world to get a peek of their parent museum; AI artificial catalogues records large collections of artifacts; cultural calendar fits into schedule of ceremonies [1][2][5].

Pemayangt Monastery

The oldest and most historical monasteries of Sikkim was Pemayangtse which was founded in 1705. The wooden structure is a three-story house which is composed of a renowned sculpture Sang-Thok-Palri which is an embodiment of Buddhist heavenly realms.

Documentation Requirements: High resolution work on historical murals in different periods; 3D recording of the wooden sculpture on 7 levels; multispectral imaging, revealing the bottom layers of paint; documentation of the traditional building technique [8][24][26].

Platform Application: Records on ancient crafts techniques are stored in digital archives; virtual touring enables individuals to view delicate interiors that should remain closed to visitors; AI analytical methods can be used to designate the age of artistic works and the restoration needs [11][15][17].

Enchey Monastery

Enchey is located near Gangtok and it is one of the minor monastic institutions that are prevalent in Sikkim. It possesses a vibrant ritual activity characterized by significant yearly mask dances and ritual performances.

Documentation Requirement: 360degree recording of small shrine rooms; recording of ritual performances on video, audio recording of rituals chanting, oral histories of the community community [2][4].

Platform Application: Physical visitor experience can be enhanced with help of the smart audio guides; visiting the festival can be promoted with the help of the cultural calendar; community involvement in the development of the content can be further stimulated with the use of the community participation [22][23].

EXPACT IMPACT

Tourism Enhancement. Monastery360 is concerned with the problem of inaccessibility that limits the possibilities of the monastery tourism in Sikkim. Virtual tours are exploration tours in advance where the tourists get to select the destination and make their itineraries [1][4]. The interactive mapping simplifies the navigation of the visitors to the remote monasteries and connects the visitors to the local services. Smart audio guides have the advantage of enhancing experience of individuals on-site without necessarily requiring them to have one-on-one personal guides. The improvement in the tourism is estimated as being consistent with research that shows that 30-40% of the tourism visitation can be improved with the implementation of digital heritage platforms [13][16].

Cultural Preservation

Digital documentation will help in having permanent documents that will reflect the prevailing state of the monasticries in case of damages or losses in future [6][27]. The need to conserve can be noticed early through deterioration detection based on AI [15][18]. It is so because in digital archives, manuscripts and works of art can be looked upon at all times even in cases where the original is no longer accessible. The revenue generated using the platform can be used to uphold physical conservation.C. Community Empowerment

Participatory archiving practices involve the participation of the local population in documentation and interpretation of heritage [22][23]. The jobs are created in the areas of content creation, guide services, and platform maintenance. With the use of the digital resources enhancing preservation of traditional knowledge, cultural transmission is strengthened. The digital heritage assets are owned by the community where they can be culturally represented [24].

Educational Access

Educators all over the world find the materials to teach Buddhism studies, Asian history, and Asian cultural heritage [4][15]. The researchers gain access to consolidated archives once needing to visit physically several places that were scattered in different locations [12][25]. Students can also have a realistic virtual field trip that would not have been possible using traditional classroom resources. Collaboration among scholars enhances due to common digital infrastructure [30].

DISCUSSION

Technical Feasibility

Literature review proves that technologies needed to implement Monastery360 are not new, and they are effectively used in similar heritage settings [1][5][6]. The development of frontend prototypes

confirms the ideas of user experience and interface viability. Other similar platforms such as Google Arts and Culture and CyArk show that they are viable at scale [22][23].

Considerations of Implementation.

Implementing this successfully would involve a challenge on infrastructure constraints in remote areas in the Himalayan ranges. Offline capability makes it usable in case of connectivity limit. Integration of the community at early phases creates trust and guarantees the culturally apposite content [22][24]. The implementation can be done in phases with a few pilot monasteries first, to refine what is needed before it is rolled out to the masses.

Ethical Considerations

The digitalization of sacred spaces is to be approached carefully to religious guidelines and community approval [23][24]. Some confined zones or places might reasonably not be documented following the guidelines of the monastic authority. Religious practitioners who want to go to a certain place should not be deprived of physical pilgrimage in favor of virtual access. The models of revenue sharing should provide benefit of heritage commercialization to the communities.

Sustainability

Diversification to provide long term platform sustainability needs to incorporate government heritage funding, tourism revenue, educational licensing and community contributions [19]. Technical expertise and hosting is offered by institutional partnerships with universities and cultural organizations. infrastructure. Capacity building develops local skills for ongoing content creation and platform maintenance.

Limitations

This study shows conceptual framework and front end prototype and not the fully implemented system. Future development is needed in Backend AI processing, database infrastructure and full VR experiences. Impact measurement and user testing are still waiting to be fully implemented. Generalization to other heritage settings needs to be proved by further case studies.

CONCLUSION

Summary

This study considered the problem of digital preservation of the Sikhim 200 and more Buddhist monasteries by proposing Monastery360, a platform that will integrate AI and VR technologies. Three literature reviews of 30 scholarly sources conducted the systematic literature review that set the technological framework and revealed the gaps of the current methods. The proposed platform will combine virtual tours, interactive maps, AI-driven archives, smart audio tours, and cultural calendars into a single platform that fulfills the needs of tourists, researchers, and the community.

Rumtek, Pemayangtse, and Enchey monasteries case studies showed the platform usage in different monsteries. Technical feasibility and user experience design were checked in the development of frontend prototypes. The impacts that are expected to be realized are improved preservation, empowerment of communities, increased access to education and improved tourism.

Contributions

The contributions of this research are:

(1) the synthesis of the literature regarding AI/VR applications to Buddhist heritage
(2) the identification of the preservation gaps in terms of Himalayan monasteries;
(3) the design of the Monastery360 platform incorporating five functional modules;
(4) the case study framework of Sikkim monastery documentation;
(5) the case study framework of Sikkim monastery documentation;
(6) the validated frontend prototype that will prove viability;
(7) the impact assessment framework of digital heritage platforms.

Future Work

Future research directions are: full backend implementation with AI processing option; development of VR experience of immersive virtual tours; user testing and further refinement; pilot implementation to specific monasteries, longitudinal impact analysis and adaptation of the framework to other Himalayan heritage locations.

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