

# Towards Documenting and Preserving Living Traditions and Heritage: Problems and Potentials of Emerging Digital Technologies

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## Abstract

Today, the world is fast progressing with the introduction of modern technologies affecting almost every field of studies and practices. Same applies to the documentation of heritage structures. Invariably, new ways have to be devised in addition to the existing ways of manually producing drawings and written texts. In other words, it is necessary to employ digital ways to document the heritage structures, to map historical terrains, and to recreate records of archaeological ruins of settlements and structures. Moreover, Geo-tagging information could be used for easy accessibility and preservation and regeneration of heritage. In this context, this paper looks into such technologies which can play a supportive role in documenting and providing data collection tools for conservation and promoting cultural heritage. It therefore examines the potentials of the new technologies and their problems.

Options are numerous: Documentation of built environments and specially the cultural heritage, could be enhanced by various technological advancements such as drones, photogrammetry, LiDAR, Geo-tagging and virtual tours. Afterwards, they can be used for conservation or to showcase historical events to locals and tourists. Photogrammetry enables precise measurements and conditional assessments of structures through photographs. In fact, AI can aid architects and conservationists by providing on-site markings, Geo-mapping, and detailed site information via an app.

This research explores the available advanced technologies which can aid in heritage restoration, discussing their potential benefits. The methodology involves reviewing various software to reveal how AI could help in future applications for documenting heritage. It begins with a literature review followed by constructing knowledge from a professional workshop.

The paper proposes the use of AI merged with other technologies to create precise drawings and sketches with accurate measurements. It concludes that photogrammetry and LIDAR sensors equipped with AI can encourage digital documentation of physical and cultural heritage. The paper provides proposals for further research related to industrial applications to create a common interface with interlinked digital systems.

**Keywords:** Heritage, Archaeological Ruins, Photogrammetry, Artificial Intelligence, Documentation, Geo-Mapping

## Introduction

In the modern world, digital computations can handle complex tasks with far more precision and at a higher speed. For this reason, the future will be in digitization to carry out almost everything. However, digitization has already swept over many fields and has seen a direct impact on both creative as well as monotonous work. Undeniably, it has taken a toll on the work opportunities of people, but will also create other work opportunities. Nevertheless, it is hard to deny the usability and precision of artificial intelligence which would yield tremendous progress when mixed with human intelligence. One such case is the field of architectural and cultural conservation, preservation and regeneration, where manual sketching, drawings and text documentation are being taken over by digital technologies.

To understand the terminologies, here are the following abbreviations used in the paper. The various technologies are - AI (Artificial Intelligence), GIS (Geographic Information System), BIM (Building Information Modeling), HBIM (Heritage Building Information Modeling), Li-DAR (Light Detection and Ranging), VR (Virtual Reality), AR (Augmented Reality), and CH (Cultural Heritage).

The digitization process has been introduced to many areas that need new approaches to the documentation of the built environment. In this connection, Carlos et al. (2023) show that GIS, BIM, HBIM, and laser scanning are tools commonly used to map and acquire digitized data related to heritage. Furthermore, Li-DAR scanning sensors in applications equipped with 3D structural simulation and AI help document the heritage structures in lesser time with greater detail-capture than conventional manual work. Moreover, sketches and photographs could be Geo-tagged to the 3D structural simulations to provide complete comprehensive guides to the conservationists, and also to the communities in general.

The issue is that new digital technologies have come into being, but there is a lack of proper information and evaluations of these methods. Nevertheless, the explorations of these methods with the rise of AI have given various future possibilities of common platforms to digitize building data contributing to a well-managed and precise flow of data. A precise documentation allows the demarcation of affected site areas, structural issues and vegetation growth in the form of real-time simulations and videography. In fact, historical knowledge with the help of artificial intelligence could be used to regenerate degenerated structures and contribute to the revival of lost history. There are strong opportunities to create a proposal for the future where AI plays an important role in merging digital data of heritage buildings and reviving the skills and traditions of our ancestors for a living heritage. In this context, this research explores the available advanced technologies which can aid in heritage restoration, discussing their potential benefits. Its aim is to bring to light the emerging field of digital documentation so that the techniques can be further, explored, employed in dealing with the built-environments; especially the cultural heritage.

The objectives are as follows.

1. To collect literature and reveal the various technologies available.
2. To analyze the potentials and issues of these software when merged with AI for a common interface.

## Theoretical Framework

### Digitization and Digital Ways of Documenting

According to the Oxford Dictionary, digitization refers to the conversion of text, pictures, or sound into a digital form that can be processed by a computer. According to Pellicelli (2022), it refers to the process of converting analogue material into a digital format, typically for storage and use in a computer. Here, digitization refers to the process of having the data digitally in software with a priority to make it easily accessible everywhere and to everyone.

AI, along with advanced technologies like Li-DAR sensors, Photogrammetry, GIS and BIM can be enhanced into integrated applications with combined functionalities and innovative

features. These AI technologies can be adopted to automate the inspection process for CH structures (Mishra et al. 2024). These technologies can provide detailed analyses, accurate measurements, and comprehensive data visualization. By combining these tools, we can develop more effective solutions for heritage conservation, urban planning, and architectural restoration.

## Research Methodology

This research is carried out using a literature survey and on-site experience during a workshop as the methodology. The authors attended a three (3) day workshop (INTACH) related to photogrammetry, in Delhi from 11th-13th December, 2023. The authors studied the presentations and the methodology involved note taking at the workshop and the primary data collection from the specialist on-site, followed by self-reflection. In the workshop, parallel and angular geo-tagged photographs were produced on-site at Jamali Kamali Masjid, Mehrauli Archaeological Park, New Delhi.

These photographs were uploaded to software like Metashape Pro and then converted to point cloud data. Layer by layer, surfaces and textures were added, and the 3D documented model of the site structure was formed. The research also sourced data from a literature survey producing secondary references (online) through which various research papers have been published pertaining to this topic were located and studied.

## Findings

### A. Findings from the Survey of Literature

Altogether 12 sources of literature were found through the survey. They were thoroughly studied in terms of the contents while noting where the gaps of knowledge pertaining to the issue exists. The sources of literature and the findings are as follows.

**Table 1:** Sources Derived from the Literature Survey and the Findings

Source: Author

Sr. No.	Title	Author	Type	Gap
1	A Critical Review of Automated Photogrammetric Processing of Large Datasets.	Remondino, F., Nocerino, E., Toschi, I. & Menna, F. (2017)	Journal	Lacks information related to documenting intangible aspects of heritage and the dynamic part of the community and culture.
2	AI Applications in Cultural Heritage Preservation: Technological Advancements For the Conservation.	Akyol, G. & Avci, A.B. (2023)	Article	Lacks information related to processing efficiency over large datasets from diverse sources.
3	AI in Art and Cultural Heritage Conservation.	Ibrahim, M. (no date)	Online Article	Mostly analyses of the tangible art heritage.
4	AI Integration in Cultural Heritage Conservation–Ethical Considerations And The Human Imperative.	Ghaith, K. (2024)	Journal	Doesn't explore fully how AI can be integrated and being interactive in community-driven cultural heritage.
5	Artificial Intelligence and Cultural Heritage: Design and Assessment of an Ethical Framework.	Pansoni, S., Tiribelli, S., Paolanti, M., Di Stefano, F., Frontoni, E., Malinverni, E.S. & Giovanola, B. (2023)	Journal	Lack of any framework for changing and evolving cultural datasets.
6	Artificial Intelligence for Digital Heritage Innovation: Setting Up a R&D Agenda For Europe.	Münster, S., Maiwald, F., di Lenardo, I.,	Journal	Focus on European R&D vs. Global Heritage Practices.

		Henriksson, J., Isaac, A., Graf, M.M., Beck, C. & Oomen, J. (2024)		
7	Artificial Intelligence-Assisted Visual Inspection For Cultural Heritage: State-of-the-Art Review.	Mishra, M. & Lourenço, P.B., 2024.	Journal	Lack of Participatory AI Approaches.
8	Building Information Modelling, Artificial Intelligence and Construction Tech.	Sacks, R., Girolami, M. & Brilakis, I. (2020)	Journal	Lack of Application to Non-Structured Cultural Heritage.
9	Learning From Practice in the Digital Age: 'Digitization of Heritage in New Zealand'.	Khan, I.R., Jadresin Milic, R., Su, B. & Vadász, V. (2024)	Journal	Focuses on New Zealand but does not discuss community and culture-driven documentations.
10	Machine Learning Techniques For Structural Health Monitoring of Heritage Buildings: A State-of-the-Art Review and Case Studies.	Mishra, M. (2021)	Journal	How is machine learning used for cultural practices?
11	Mobile 3d Scan Lidar: A Literature Review.	Di Stefano, F., Chiappini, S., Gorreja, A., Balestra, M. & Pierdicca, R. (2021)	Journal	How is 3D Mobile scanning implemented in communities at grass-root level?
12	Study on the Quality in 3D Digitization of Tangible Cultural Heritage: Mapping Parameters, Formats, Standards, Benchmarks, Methodologies, and Guidelines: Final Study Report.	Ioannides, M. (2022).	Report	There is a lack of any methodology for dynamic cultural practices and multi-sensory recordings for documenting dynamics.

With the above analysis of gaps present in the references, certain inferences have been drawn out. First, there has been a major gap in studying how the intangible cultural heritage driven by the local communities are documented and preserved using AI. There is a gap in the methodological framework for dynamic practices in society. These gaps have been addressed in the paper by addressing the issue with the use of AI merged with software for not only professional purposes but also for experiential data for promoting tourism of cultural heritage sites.

In New Zealand, research is being conducted on the existing knowledge of heritage and contemporary methods of digital preservation. The authors have uncovered that there are stages within the digital preservation process that contribute to the promotion of cultural heritage.

These stages are identified as follows.

- (1) Data collection on-site using digital tools;
- (2) Data processing on software;
- (3) Development of a 3D model and 2D drawings;
- (4) Processing of visual material (renders and animations); and
- (5) Data sharing and management among consultants for conservation, tourism, education, etc.

Khan et al. (2024) points out that it is important to develop the use of these methodologies in New Zealand, to ensure that heritage values are encouraged and preserved for the future generations. However, these strategies could be used not only as a guide in New Zealand but also across other countries because in the paper titled 'Learning from practice in the digital age: 'Digitalisation of heritage in New Zealand'', it is concluded that, "It is necessary to involve representatives from the government, community, academia, industry, and cultural heritage experts to accomplish these goals." In every country, different field professionals are required to come together and combine datasets for a holistic preservation of the cultural heritage.

## Artificial Intelligence with LIDAR and BIM

Today, artificial intelligence plays a vital role which involves making everything more accessible and editable on software and digital data. It allows proper detailed documentations and annotations to be preserved at a common platform. Applying computer science techniques such as Artificial Intelligence (AI), Deep Learning (DL), and Computer Vision (CV) on digital image data can help monitor and preserve cultural heritage sites. Defects such as weathering, removal of mortar, joint damage, dis-colouration, erosion, surface cracks, vegetation growth and structural damage due to its roots, seepage, and vandalism and their propagation with time adversely affect the structural health of cultural heritage sites. Several studies have reported damage detection in concrete and bridge structures using AI techniques (Mishra et al. 2024).

Advanced 3D scanning technologies like LiDAR use light or lasers to capture the shape and dimensions of objects in three dimensions to create highly accurate digital replicas or models. As discussed in the case studies earlier, LiDAR is a common and powerful tool for virtually preserving cultural heritage. Being a non-contact technology, LiDAR can be used to survey and measure heritage sites without touching or disturbing them, which is crucial for fragile or inaccessible sites. This is why most of the digital documentation processes use 3D scanning tools and processes to digitally conserve a heritage site or artefact (npj Heritage Science, no date).

AI can be crucial in digitizing cultural artifacts and archives. Through digitization, AI accelerates the process of encoding cultural heritage thereby enabling scholars as well as the general community to research oddity items online. A number of articles offer general information about specific technologies, for example on 3D acquisition – laser scanning (Di Stefano et al., 2021) or photogrammetry and characterize their application (Ioannides et al. 2022). Regarding the limitations we can state that AI-based systems can control cultural heritage site environmental conditions and react to potentially hazardous factors apart from security issues, such as humidity, temperature variations, structural damage, etc., in case they are detected by the system. This real-time monitoring helps in the early intervention in the conservation and protection of cultural landmarks (Mishra, 2021).

A new software equipped with artificial intelligence could be used to collect, comprehend and categorize image data. In the field of conservation, preservation and regeneration, a set of measured drawings, condition assessment drawings and proposal drawings are prepared. Condition assessment drawings are drawings made with multiple layers of crack formations, degradation of walls, vegetation growth on structures, rusting of iron, and debris collection. With the help of artificial intelligence and digital image data processing, software's could be equipped with LiDAR sensors to help measure the dimensions of the building and Geo tag dimensions to the particular wall or part of structure, and with the categorization feature, the image data could be translated to categories differentiating between vegetation growth and debris collection, and others, and calculating the quantity of each to aid in the cost of removal and restoration of the heritage structure. With this technology of detecting the issue in structures with their quantities, it becomes an aid to the building information modelling, where issues could be seen and managed in real time with regular interval supervisions.

## Photogrammetry

Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring and interpreting photographic images and patterns of recorded radiant electromagnetic energy and other phenomena (McGlone, 2004). Indeed, it is a technique of taking multiple photographs of an object or a site from different angles and combining them to create a detailed 3D model. It is particularly used for capturing the surface details of artifacts and structures through high-resolution or VR cameras or drones (npj Heritage Science, no date).

These two definitions describe the process of manually capturing overlapping parallel photographs of a heritage structure at all angles, and capturing photos of the built facade and site context through drones. It allows a detailed capture of the structure and cultural context which documents the activities as well as the structural deterioration and built form. The

captured image data is transferred to software such as Metashape Pro, and segregated into various layers of point cloud, geometry, material, and texture. The image is processed in these various layers and eventually a 3D information is built digitally where markers are placed for Geotagging the photographs to the right location in the building. This technique allows a photographic documentation of the heritage structure.

As technologies for ending structures and Structural Health Monitoring (SHM) are appearing, different sorts of data are emerging within the sphere of preservation of heritage. Historically, vibration response has been considered the most popular data in SHMs for a long time. However, due to advanced learning for image processing, the researchers have started to consider odyssey damage detection by using image and 3D point cloud data. Other sensing techniques include UAVs and cameras which have been used as substitutes for the visual inspection of heritage damage. According to Akyol et al. (2023), smart damage identification methods using concepts in artificial neural networks have been promoted to reduce the involvement of human hands. In fact, this has attracted a lot of interest.

### **Geographic Information System (GIS) and Mapping**

Geo-tagged photographs and drone shots capture the site context in the form of parallel photographs which overlap to create a digitally stitched image data. These Geo tagged photos have the Geo-spatial data separated and categorized by the artificial intelligence. The software GIS allows mapping of data across the city with layers of photographs, transits, heritage precincts and also annotates the status of the maintenance or level of archaeological/ architectural/ conservation work prevailing there. This integrated use of Geo-spatial data and GIS technology ensure that heritage sites are documented with precision while the patterns or connections could be mapped of the historical and cultural remains across the urban fabric. GIS shall also provide features to mark site analysis and data generation of census and tourist population for a better understanding of a cultural heritage site. In fact, Li-DAR can be used to map distances and patterns between heritage structures and sites at a larger scale.

### **Geographic Information Systems (GIS), Building Information Modelling (BIM) and Digital Modelling**

Geo-tagged photos along with Geo-tagged 3D model simulations provide contextual as well as site data for cultural heritage sites for interventions, and conservation and restoration. These models can be equipped with Building Information Modelling (BIM) which allows multiple layers of texture, material, structural issues, and others to be addressed by the conservationists and architects for preservation and restoration.

Digital modelling is also used for research and education of heritage assets. For conservationists and researchers, these digital models serve as a valuable resource enabling them to monitor changes and deterioration of the sites and artifacts over time as well as restore or reconstruct lost or damaged parts of heritage sites. Technologies like AR, VR, AI, and machine learning are increasingly being used to analyze and interpret data from photogrammetry and 3D scanning in terms of identifying the patterns, predicting deterioration, and suggesting conservation strategies (npj Heritage Science, no date).

### **Artificial Intelligence and Virtual Reality**

Digital preservation involves methods of recording, analyzing, displaying and disseminating information about architectural heritage in a comprehensive, accurate and efficient manner using DTech such as three-dimensional (3D) scanning, modelling, visualization and virtual reality (VR) (npj Heritage Science, no date). Artificial Intelligence and Virtual Reality are two software packages which have the ability to search and to display.

In fact, virtual reality is used in lenses to visualize the surroundings and the immediate contexts in 3D simulation. This virtual simulation when mixed with the datasets of historical and cultural data can help document the heritage structures in real time with captured photographs zoomed in and out and with marked detailed features and annotations as per the

conservationist/ architect visiting the heritage structure. Additionally, AI can analyze the structural remains to predict the period, style, and original appearance, guiding accurate restoration.

### **Regenerating Cultural Heritage**

Artificial Intelligence that understands cultural history can be a revolutionary tool in heritage conservation. With AI, that has the ability to learn the built typology and historical data, it is possible to make it recognize the architectural features such as styles, materials and methods of construction of the historical structures. This technology can then suggest what the regeneration models or the actual visual representations of how these structures seemed like originally. Such capabilities are useful in reconstructing ruined structures; monuments that have been attacked and broken structures that have historical messages as well inscriptions.

This makes a decision-making process for the conservationists as AI may analyze the structural remnants, decode the stylistic element and even foretell the architectural forms. For instance, it is able to discern the different features in the remnants and calculate how the gaps in it can be filled in accordance with the original model. This process also helps in not only the conservation of the existing structural components but also in the reconstruction of the missing or repaired areas thereby enhancing the appearances of the heritage site.

Furthermore, by integrating AI with other technologies such as Li-DAR, photogrammetry and GIS, it can offer a complexity that will support the restoration process. Because of this, the data gathered by these technologies regarding structural conditions can be used to generate almost perfect versions of the real structures. This approach plays a role in the selective and careful restoration with regard to culture and history besides utilizing the scientific methods for the restoration of the lost splendour of these cultural icons.

Two main technologies are currently being used in the art and cultural preservation field: They are artificial intelligence (AI) that includes computer visions and Natural Language Processing (NLP). Based on these fields, documentation, restoration and access to historical artifacts and artworks are being revolutionized. Computer vision is applied in artificial intelligence to enable the cataloging and restoration of cultural heritage by providing a precise identification of damaged artifacts which are then fixed by the technical officers. At the same time, there is a potential for the AI-driven NLPs in terms of translations and digitization of the language heritage in an effort to make them more available for study and education around the globe.

Indeed, artworks can be analysed using computer vision models to detect faded colours, missing sections and other forms of damage in order to restore the works. AI can pinpoint and recreate original colour and surface patterns, which will enable the conservators to make the right decisions when working on the restoration process. Machine learning may also be applied in order to determine the state of the artworks and predict further degradation in order to prevent them and suggest ways to do so. Such models are exposed to different datasets containing photos of other masterpieces, paintings in good condition as well as the ones that are damaged after a certain period of time. From the examples, the model learns how to identify signals that may point to the early signs of deterioration. AI can also help in creating digital replicas and virtual reconstructions of historical sites, providing immersive experiences while minimizing physical interaction with delicate artifacts. These digital models serve as valuable references for restoration and educational purposes (Ultralytics, 2024).

### **Role of Documentation in Heritage Tourism**

Heritage tourism plays an important role in any local economy and the revival of ancient cities which may or may not be abandoned. To enhance the tourist experiences, real-time video documentation can be utilized, providing an interactive guide through the heritage sites. By using an application, visitors can see exactly where they are within the structure and gain insights into the historical and cultural context of each area. This being easily accessible to everyone, i.e. the local community and the tourists, a sense of deeper appreciation and

custodianship is generated amongst the people. Maintenance of the structure may also be aided with this system for regular checks at locations and also to keep note of the restoration work done for a particular area. Software applications can be devised wherein live time checks on the heritage structures could be kept and prevent the structures from being raided by the tourists.

### **The Usage of Technologies Supporting AI**

Software and technologies using AI and building algorithms can be also employed to construct or reconstruct existing and proposed additions and extensions to cultural heritage. Essentially, there is a need for complex event processing. This would entail the merging of information from multiple monitored data sources with already existing information about the as-is status of a construction site and the production plan, to deduce accurate information about what has been built, how, and what resources were used and where merging/fusing data were done from multiple sources to compile comprehensive information about project status (in terms of both product and process status).

However, complex event processing is possible only on the basis of well-integrated and reliable data, something we still lack. Although data is available in apparent abundance, the current lack of comprehensive, accurate and reliable linked data and information naturally restricts the opportunities to properly exploit the technologies (Sacks et al., 2020).

Building information and its categorization involves four major types: They are:

1. Design and management,
2. BIM to field,
3. Field automation,
4. Field to BIM.

All these categories are interdependent on each other in terms of their relevant software. In fact, there are several limitations to these applications: inadequate circulation of information, difficulties in framing data models for the base of design and management software, and the digital intelligence of the seamless transition between field and BIM tools.

With respect to the addition and changes done to the Cultural Heritage Sites, the process of conservation, preservation and restoration recurs bringing in documentation, maintenance, and tourism challenges. Certain practical applications of AI can happen with the integration of distinguished images with natural language documentations. In fact, the potential of AI can lead to specific computational techniques and data modelling. Undoubtedly, a human-centric approach in AI applications is required for enhanced museum experience and preserving both intangible and tangible cultural heritage.

It is essential to recognize the potential of AI for CH preservation and diffusion. On the other hand, it is crucial to outline ethical and moral considerations when employing AI in a cultural context. In particular, the use of AI for conservation of living CH may be subject to cultural and historical biases, and there is a risk that minorities will not be represented. Secondly, the digitization of CH can lead to problems related to artificial reproduction such as authenticity or replacement of the physical artwork. Other challenges related to the distribution of economic resources, the allocation of responsibility, and the protection of privacy emerge from the analysis of literature and should be considered for a trustworthy application of AI in CH (Pansoni et al., 2023).

Despite these, there are both advantages and disadvantages of employing digitization of cultural heritage. They are as follows.

### **Advantages of Using AI and Technologies**

- Easy documentation with user friendly tools
- Capturing conditions for conservation, preservation, restoration and regeneration
- Preserving details for cultural heritage and archaeology
- With the help of drones, certain areas on the site could be easily accessed and documented which may not be possible to reach on foot.

### Disadvantages / Issues of Using AI and Technologies

- Difficult to generate detailed models by everyone, only used by professionals
- No platform where photogrammetry, AI, LiDAR, BIM and other such technologies are combined to ensure a seamless transition between software's to develop a project and execute it from documentation, condition assessment to final drawings
- Environmental conditions, shadows due to certain elements, and thick vegetation increase the chances for error and provide less detailed models with uncertainty.

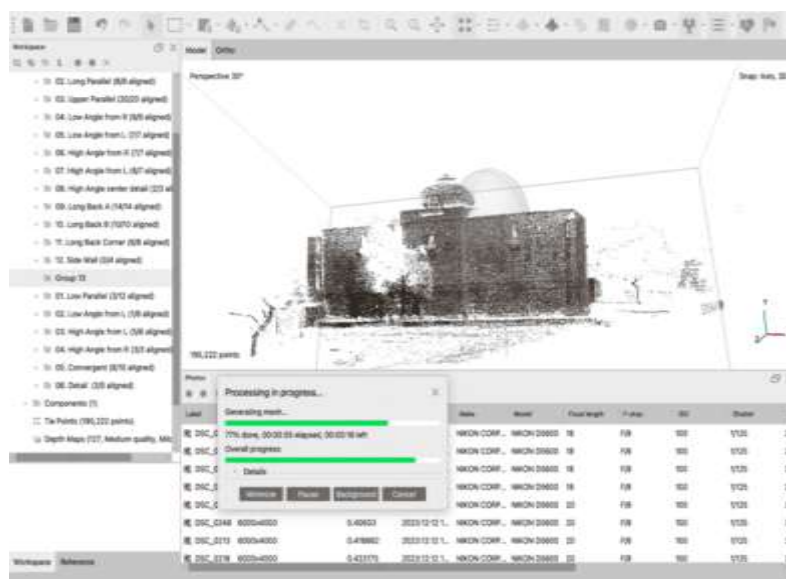
### Findings From the Workshop

During the workshop which was the second method, the researchers participated and studied in detail the digital methods now available documentation of heritage. As an illustration during the workshop, the Mehrauli Archaeological Park of New Delhi, a monument of Jamali Kamali was recorded employing photogrammetry to understand the process of taking RAW images and digital negatives using DSLR. Data from the image are loaded to a software known as 'Metashape-Pro' through which they are processed in layers of point cloud references, solid colour fills, and textures producing 3Ds of the monuments. Trees and vegetation are removed for a better appearance.

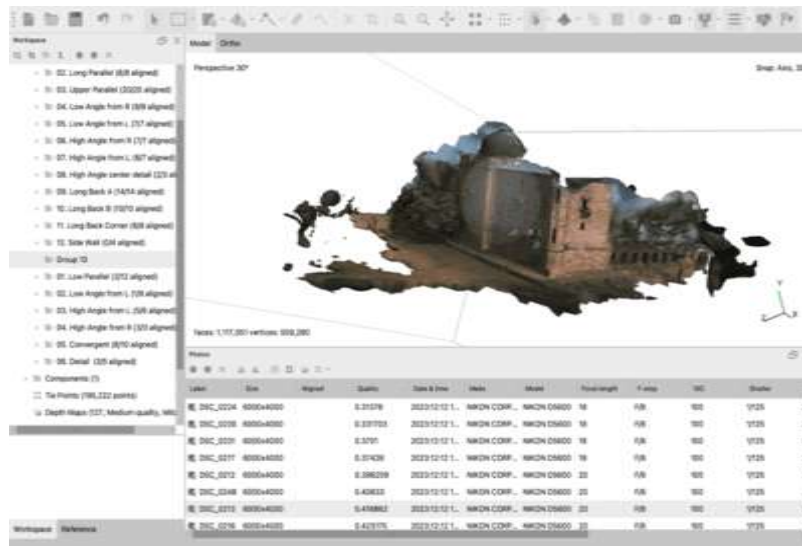
Following are the outcomes of this workshop. They demonstrate how data are generated in terms of visual images and then transferred as digital data.



**Fig. 1:** DNG File of the Side Elevation: A building in the Mehrauli Archaeological Park of New Delhi  
Source: Author, 2023



**Fig. 2:** Generating a Point Cloud  
Source: Author, 2023



**Fig. 3:** Adding Texture to a Model  
Source: Author, 2023



**Fig. 4:** A 3D Model Produced as the Final Output  
Source: Author, 2023

Following observations were made at the workshop.

1. Documentation using digital methods has evolved over a long period of time. This has started with surveying and levelling, and mapping the context and measuring the heritage structure. The process has now reached manual drawings and drones and soon shall reach artificial intelligence to document and survey the sites and the structures.
2. Materials produced using artificial intelligence with the capability of text and images can be tested in labs between the researchers for their ability to inculcate historical knowledge and generate 3D simulations of the heritage structures along with annotations of the cultural history and the events.
3. Drones can be programmed to perform these tasks, while an application can make this technology accessible, aiding the restoration of partially ruined temples and the heritage sites.
4. Artificial Intelligence with Li-DAR and BIM can be tested in labs to recreate the blueprints and regenerate 3D models of culturally and historically important religious structures, havelis, and even archaeological remains to understand the history and civilizations better.
5. Artificial Intelligence with GIS could be tested in labs for on-ground photography and Geo-tagging photographs and important locations around a cultural heritage site which may or may not be spread over a large area. Archaeological sites shall find it easily usable and editable to map the different locations and their past history events.

6. Artificial Intelligence with Virtual Reality can be tested in labs for on-ground situations when VR lenses are worn by the architects and the conservationists. Photographs are made of the heritage structure as per their choice through the lens using the digital zoom. These photographs shall also have the feature to add historical and cultural data for labelling the times when the photograph was taken. With Geo-tagging and Li-DAR sensors, measurement could be recorded on-site with precision directly feeding into the system.
7. Various datasets shall be merged and overlapped to provide a flow throughout the use of software technology. This accounts for easy archival methods and digitization throughout the process for good quality documentation and ease of circulation of data. Common platforms with these combined features of artificial intelligence, such as BIM, GIS, and Li-DAR allow a dataset to be edited seamlessly and with great precision. Based on these data, a regeneration or a restoration project can be proposed.

However, It is noted that AI and merged platforms have a setback on the documentation of details which the human eyes usually perceive and understand upon interactions. Moreover, it is necessary to learn complex software to handle the programs. Since AI is not human, there may be errors in recognizing and categorizing data on-site or forming 3D models with buildings having heavy vegetation growth. Hence, a collaborative approach shall work better by combining human skills and AI together, instead of depending entirely on AI and software for all the data collection, segregation and processing.

## Discussion

In this paper, learning from practice in the digital practices in the project ‘Digitization of heritage in New Zealand’, and the validity of making use of digital models and their Geospatial data in the context of cultural heritage conservation is observed. Thus, this research helps in promoting technological collaborations with artificial intelligence to produce documentations of cultural heritage. At the end of this, some proposals are made according to the software and AI based on their potentials and problems to be merged together for a common platform.

The research showed that it would be possible for CH sites and artifacts to be thoroughly analysed with the help of AI algorithms and understand the nature of the data and the importance of sites reviewed by the historians. This can be useful in decisions related to what has to be conserved or preserved as well as in the thought process of these measures. Geomatics as a field of study that deals with the collection, processing and analysis of spatial data has been instrumental in documenting and digitizing tangible CH.

Photogrammetry, Li-DAR, and 3D scanning are the methods of geomatic technologies that enable the production of high-quality digital models of CH sites and the artefacts. These digital models can be employed for various tasks such as conducting research, initiating conservation as well as creating awareness.

In addition, geomatics has created what is known as Virtual Reality (VR) and Augmented Reality (AR) experiences for CH that could provide the clients with opportunities for immersion. It has thus invented ways of documentation and dissemination of tangible CH for the future generations. As Pansoni et al. (2023b) shows, Geomatics and AI did expand new approaches to enhance the management of Digital Cultural Heritage (DCH).

Thus, assisted by an innovative technology in the form of artificial intelligence, these features shall work in harmony, in order to rebuild or reconstruct the existing structures, which may or may not currently be in a state of disrepair.

## Conclusions

The paper concludes that in the modern times, where machines and technologies play an important role in the industrial sector, the process of documenting intangible and tangible parts

of cultural heritage becomes a key point to maintain the flow of knowledge to the coming generations. It also enables digitizing the process of restoring and regenerating heritage either lost or damaged.

The paper proposes the merging of artificial intelligence with different software that will make the system for data analysis broader. This system would logically categorize Geo-spatial data for better understanding of cultural heritage structures on-site. One suggestion is the integration of photogrammetry with AI to create one single platform where data in the form of Geo-tagged photographs can be processed and extracted directly from the photographs and interpreted. It is argued that such integration makes it much easier to detect the architectural elements, historical context, and the structural conditions from the imagery.

This integrated system would enable an efficient transfer of data to Building Information Modelling platforms, hence establishing a real-time link between the paper-based documentation and the digital models. By adding cultural and historical notes, software is able to present a more informative interpretation of the site in terms of structural problems and define particular areas inside antique constructions or the sites of the archaeological digs. Such annotations would help in restoring the artworks in question with even more precision. Indeed, they could also be useful in educational and interpretive contexts to specialists as well as the general visitors.

Moreover, the proposed system can also be easily adaptable and used by conservationists, architects, and researchers. Information can be modified by them based on the data collected. The problem of merging AI with other software may make the data to be stored at a common location which may risk the safety and security of the data. However, it may require only highly-skilled labour to help function the data processing software to feed in the on-site data to the software for 3D modelling. In fact, the potential of AI merging with other software resides in the ease of data access and precise collection for detailed conservation, preservation and restoration.

The workflow of data between AI, photogrammetry, and BIM is perfect in this regard. It results in a systematic approach to the management of heritage. Furthermore, it helps in the conservation of the physical structures of such places but also in the protection of the stories behind such places. By doing so, the paper foresees the day when the application of IT would be complementary to conservation and revitalization of cultural heritage, thus enhancing the efficiency of efforts directed towards the promotion and sustenance of culture.

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