

Original Research

Received 21 May 2026

Revised 30 June 2026

Accepted 23 July 2026

Natural Resources for Human Health 2026, Vol. 6 (9s): 441–455

KEYWORDS:

Artificial Intelligence, Internet of Things, Digital Cultural Heritage, Mahasu Maharaj Traditions, Cultural Documentation, Oral Narratives, Digital Preservation, Uttarakhand Heritage.

Digital Documentation of Cultural Narratives, Rituals and Processions: A Study of Mahasu Maharaj Traditions in Uttarakhand using AI and IoT

Santosh ¹, Dr. Anita Goswami²

¹ Research Scholar, COER University, P.B. No. 27, 7th KM on Roorkee Haridwar Road, Vardhmanpuram, Roorkee 247 667, Distt. Haridwar, (Uttarakhand) India.

Email: santoshrwt91@gmail.com

² Associate Professor, COER University, P.B. No. 27, 7th KM on Roorkee Haridwar Road, Vardhmanpuram, Roorkee 247 667, Distt. Haridwar, (Uttarakhand) India.

Email: anita.goswami.eng@coeruniversity.ac.in

ABSTRACT: The use of artificial intelligence (AI) with internet of things (IoT), is proposed as a way to document and preserve the Mahasu Maharaj traditions of Uttarakhand. Traditions are a source of historical information and also provide evidence of what makes a culture or community. However, it has been documented that many traditions have lost their importance and have become less practiced by youth. The AI-IoT based system proposed would include five layers: Data collection from cultural activities, Sensing and recording using IoT technology, Analyzing and processing cultural data using AI, A digital store of all cultural data collected, Access to the digital cultural data via user interface. These layers will allow the documenting of all aspects of the tradition using IoT enabled devices (e.g., Smart Cameras, Audio Sensors, Wearable Devices, Location Based Sensors). AI techniques (Natural Language Processing, Speech Recognition, Computer Vision, Machine Learning) can be used to analyze, classify and organize the cultural data. The proposed methodology provides a structure for the organization and management of cultural digital assets, but allows the continued participation of the community members in the development of the digital assets, maintains the authenticity of the cultural items and preserves the cultural context.

1. INTRODUCTION

Digital documentation supports the protection of cultural heritage by documenting knowledge traditionally passed down through word of mouth, through festivals, performances and participating in community life. Many traditional ways of doing things have been lost or will continue to be lost as people move away from rural areas, undergo modernization and participate less in communal activities. Digital documentation uses multimedia to document, store and manage cultural knowledge using tools such as video, photographs, audio recordings and interactive web platforms [10].

Oral stories, rituals and oral histories of Indigenous peoples are significant cultural identifiers as they give voice to shared experiences, understandings of how the world works and memories of historical times and events. Oral histories also capture unique aspects of the local culture and its history that may not be documented elsewhere. Festivals and other ceremonial processes help explain community relationships and symbols that exist within those relationships. It is essential to keep track of all these elements so that Indigenous knowledge can continue to flow to research institutions, educational facilities, and Indigenous communities [3].

Many communities throughout the state of Uttarakhand hold the Mahasu Maharaj traditions sacred. Of particular significance are the Jaunsar-Bawar area communities and surrounding regions [2]. The traditions centre upon worship of Mahasu Maharaj;

a widely revered regional deity believed to embody many aspects of local culture. Festivals, musical events, cultural procession, etc., are part of the traditional practice of worship. Most aspects of the tradition rely on community participation and word of mouth; therefore, it is vital that a systematic way of documenting the tradition exists to record the history and cultural relevance.

While culturally relevant, there are several obstacles that make it difficult to protect traditional knowledge and practices. Elderly community members possess much of the oral narrative and ritual knowledge which creates concern for possible knowledge loss when they pass away. Additionally, limitations of existing methods for documenting traditions include geographic isolation, availability of digital tools, and difficulty in capturing complex cultural expression. Lastly, cultural practices depend on native languages, symbolism, and interpretation that need to be carefully documented to accurately represent them [4].

Artificial intelligence (AI), along with Internet of Things (IoT), offer innovative ways to use digital media to create documentation systems for cultural heritage. AI enables automated collection, organization, and analysis of large amounts of cultural data through various applications including speech recognition, natural language processing, and computer vision. For example, AI could analyse oral history, traditional performances, and cultural events. IoT based devices could collect large amounts of real-time audio/video/and environmental data during cultural events using sensor-based smart recording devices and IoT networks. Both enable improved efficiency, accessibility and management of cultural heritage records [5].

In order to establish a methodical system for digitally recording cultural narratives, rituals, and processions while ensuring cultural authenticity, technology-based solutions must be implemented. Documentation systems supported by AI/IoT can aid in establishing digital repositories for the organized storage of traditional knowledge. Similarly, researchers, organizations responsible for the protection of cultural heritage, and local communities will be able to access and manage their respective cultural heritage information utilizing such technology-based approaches [6].

This paper will explore the applicability of AI & IoT technologies in digitizing the documentation of Mahasu Maharaj traditions in Uttarakhand. This paper presents a methodology for documenting cultural narratives, analysing ritual practices and managing digital heritage information. A technological solution integrating AI driven analysis, IoT based data collection and digital archiving to preserve indigenous knowledge will be proposed. As such, this research will provide a sustainable method for preserving cultural traditions while offering a structure for future digital heritage documentation projects [7].

2. BACKGROUND OF MAHASU MAHARAJ TRADITIONS IN UTTARAKHAND

The importance of Mahasu Maharaj traditions represents a rich cultural and religious legacy for people of the Uttarakhand state, especially for residents in the Jaunsar-Bawar region and adjacent areas. Local social organizations and religious systems contribute to this tradition. As such, the importance of Mahasu Maharaj traditions extends beyond its religious aspects, representing a way to remember history, to hold onto local customs and to express a sense of identity. Temples, rituals, festivals and parades dedicated to Mahasu Maharaj are also places where communities establish and maintain relations with each other and pass down their cultural knowledge [8].

2.1 origins and development of Mahasu Maharaj worship

According to Folklore and oral histories held by local communities, the origins of the worship of Mahasu Maharaj stem from regional Folklore and oral histories. The stories surrounding Mahasu Maharaj describe how he protected his followers and helped create social order in the region. The stories were passed along through generations via storytelling, ceremonies and group conversations [9].

Over time, the development of worship practices has involved local communities, religious institutions and traditional cultural systems. Temples dedicated to Mahasu Maharaj are now central locations for both religious activity and community interaction. This indicates the importance of oral traditions and community-based contributions to sustaining cultural continuity.

2.2 Religious beliefs and community relationships

Worship of Mahasu Maharaj is deeply rooted in strong religious beliefs and close-knit community ties. His devotees consider him a protector and a source of justice and prosperity. Many times, the religious rituals practiced at temples are done so in accordance with traditional custom followed by local communities [11].

While worship of Mahasu Maharaj is an individual experience, it is not limited to individual religious practice. The celebration of festivals and the performance of rituals centered around the deity are ways for communities to come together and build stronger social bonds. Collective participation in these ritualistic celebrations promotes cultural sharing among generations [13].

2.3 traditional rituals, ceremonies & festivals

Traditional rituals and ceremonies are an integral aspect of the culture surrounding Mahasu Maharaj. Activities such as, attending religious functions, conducting temple ceremonies, performing traditional art forms and participating in community events are all types of traditional rituals. Additionally, most traditional rituals are carried out with guidance from pre-established customs and typically involve religious leaders representing the local community [12].

Festivals honouring Mahasu Maharaj give communities an opportunity to keep alive traditional music, dance, clothing and ceremonial practices. Festivals are an essential method for passing down cultural expressions from generation to generation. Documenting these rituals is crucial since many practices rely on oral traditions and community memories.

2.4 processions & community involvement

Processions associated with Mahasu Maharaj traditions demonstrate large scale community participation in cultural events. Typically, these processions will consist of sacred items, traditional music, community performances and group activities. Processions display a community's cultural identity in a public setting and enable community members to take part in common traditions.

Organizing and executing these processions involves traditional roles and duties assigned to community members. The significance of documenting these processions lies in the fact that they contain valuable information regarding cultural practices, community travel patterns, use of traditional artifacts and social interactions. Through Digital means (i.e., photography/video), the documentation of these processions can preserve visual/audio/contexts for future research purposes [16].

2.5 role of oral traditions, Folklore and story telling

Story telling plays a major role in retaining cultural knowledge pertaining to Mahasu Maharaj. The majority of stories, legends, and historical accounts about Mahasu Maharaj are verbally transmitted through family/community networks. Oral traditions are an effective way to retain knowledge regarding religion, history, and cultural values [14].

Storytelling/Folklore serves as a bridge between past/present generations by providing knowledge that does not exist in written form. Unfortunately, reliance on oral transmission creates some difficulties due to changes in cultural knowledge over time/or loss of knowledge due to lack of availability of experienced/knowledgeable individuals [15].

3. DIGITAL CULTURAL HERITAGE DOCUMENTATION: CONCEPTS AND APPROACHES

3.1 Definition and Importance of Digital Heritage Preservation

The term "digital heritage" is defined as the application of digital technologies to record, store, organize and maintain cultural information over the long term so that it can be studied. This includes transforming cultural artifacts such as oral history, ritual, performance, written records and cultural practice into digital media that can be stored and accessed digitally [18].

Digital preservation has become important due to the fact that most cultural traditions are based upon oral transmission and community involvement rather than written documentation. The loss of tradition can occur in response to social change, migration, environmental degradation and decreased youth involvement. Digital documentation allows cultural records to be maintained while providing researchers, communities and educational institutions with access to these preserved records.

Digital preservation of cultural heritage may assist in documenting cultural traditions like Mahasu Maharaj's through recorded narrative, ceremony and procession containing both social and historic significance. An organized digital archive can facilitate maintenance of cultural information as well as potential research and education opportunities [17].

3.2 Tradition Methods of Documenting Culture

Historically, most culture documentation methods have utilized written records, firsthand accounts, photographs and physical recordings. Researchers and community members have traditionally documented cultural information by observing field settings, interviewing knowledgeable individuals, writing down their findings, and sharing stories about their community.

Documenting orally has provided an essential mechanism in documenting indigenous knowledge since much of the knowledge in indigenous cultures is passed down through verbal communication. Elderly members and practitioners typically hold the responsibility of maintaining information regarding traditional practices such as rituals, folktales, customary practices and past historical events.

Photographs and video recordings have also been employed to document aspects of culture such as festivals, religious ceremonies and processions. While photographic and video graphical documentation provide visual evidence of cultural practices there exists limitations inherent to each method which necessitate a great deal of manual labour and rarely capture sufficient detail relative to specific contexts [19].

3.3 Limits of Manual Documentation Methods

There exist several limits to traditional documentation methods for documenting culture. Traditionally documented methods of collecting data typically require considerable periods of time and human effort in terms of data collection organization and analysis. Documenting large cultural events with numerous activities can also prove challenging utilizing traditional methods.

Additionally, there exists other issues associated with documenting culturally transmitted oral traditions. Changes can occur within cultural knowledge during its transference from one generation to another and/or cultural knowledge may cease to exist once knowledgeable elders are deceased. Additionally, manually created records do not necessarily possess standardized formats resulting in difficulties in organizing and retrieving culturally relevant data [21].

A final limitation is the complexity involved in analysing vast quantities of cultural data. Photographs, video recordings, audiotapes, videotapes and written documents all require systematic categorization to ensure long term preservation capabilities. In addition to being categorized appropriately, without properly developed digital management systems culturally valuable information may continue to be inaccessible.

3.4 Digital Archives for Managing Cultural Information

Digital archives provide formalized frameworks for storing and facilitating access to cultural information. Examples of types of culturally relevant information that can be included in digital archives include textual documents, audiotapes/audio disks, images, videodiscs/videos, and metadata describing cultural events.

Utilizing a digital cultural archive supports knowledge management by organizing culturally relevant information in relation to categories such as thematic areas, geographic regions, traditional practices, and historical contexts. For example, a digital cultural archive for Mahasu Maharaj could potentially include oral histories/narratives, descriptions of rituals, documentation of festivals/celebrations, documentation of traditional music, and documentation of processions.

Digital archives also increase accessibility to cultural information by enabling researchers and members of communities to access cultural materials without solely relying on physically existing records. To ensure reliable access to culturally valuable digital information proper metadata management mechanisms and secure storage protocols are required [20].

4. ROLE OF ARTIFICIAL INTELLIGENCE IN CULTURAL HERITAGE DOCUMENTATION

4.1 AI Applications in Cultural Documentation

AI provides a number of important methods for documenting, analysing, and protecting cultural heritage data. Documentation of traditional culture traditionally relies on recording, cataloguing and interpreting of physical historical artifacts, which can be very labour-intensive. However, many ai methods now exist to automate the processing of large amounts of cultural data, including, but not limited to audio recordings, photographs, videos, and printed texts.

Within the domain of cultural heritage documentation, ai can assist in recognizing patterns; organizing Digital archives; and enhancing public access to cultural resources. The ability of ai systems to analyse traditional stories; recognize cultural items; organize historic materials; and facilitate the conservation of cultural heritage information makes them particularly useful when documenting complex cultural practices like those surrounding Mahasu Maharaj traditions. The documented information encompasses oral narrative, ritual performance, music and community activities.

Additionally, the use of ai-based documentation systems will allow researchers and organizations working with cultural heritage to create structured Digital records of their collections. The structured nature of these Digital records will enable connections to be made between various types of cultural information. They will also aid in the organization of heritage databases [22].

4.2 NLP for documenting oral narratives

Natural language processing (NLP) is the study of enabling computers to process, analyse and understand human language. Within the realm of cultural heritage documentation, NLP can facilitate the preservation of oral narratives by analysing traditional stories; historical accounts; and community knowledge communicated orally. For Mahasu Maharaj traditions, oral narratives provide much important information concerning religious belief; historical events; and cultural practices. NLP methodologies can aid in converting recorded conversations into structured text formats and can help in identifying the major themes found within the cultural story lines.

The NLP based analyses can aid in comparing the relative merits of competing narratives; identify repetitive cultural components; and organize traditional knowledge around thematic areas. This preserves the oral heritage which could potentially become lost due to changes in both the way language is used and the way that knowledge is transmitted.

4.3 Speech Recognition for regional language & traditional story telling

Speech recognition is the methodology by which an ai system converts spoken language into a Digital text format. Speech recognition is a valuable tool for documenting cultural traditions where knowledge is primarily passed down through spoken language.

A majority of indigenous cultural narratives have been documented using regional languages/dialects, or they have no substantial written documentation. An ai-based speech recognition system can aid in documenting these languages and traditional ways of telling stories.

For example, speech recognition would be helpful in documenting the conversations with elder community members; spiritual leaders; and cultural experts regarding Mahasu Maharaj traditions. The recorded narratives can then be put into searchable Digital record form, yet retain the unique linguistic features associated with this tradition [23].

However, there are still some challenges for speech recognition, including local language variation, speaker accent/punctuation and lack of sufficient training datasets for developing culturally-specific language models. By developing culturally-specific language models for ai-based documentation systems will increase their efficacy.

4.4 transcribing & translating cultural content using ai based methods

Transcription systems based on ai can convert recorded audio/video content into written formats automatically. As such, it decreases the amount of work involved in documenting cultural interview/ritual/stories told during storytelling sessions. Creating Digital archives that include detailed records of cultural practice can be facilitated by transcribing content manually. Additionally, translating software can make content more accessible by converting regional language into commonly-used languages while retaining its meaning in terms of culture.

As with all translations involving culturally-sensitive information, care must be taken since traditional expressions may convey symbolic meaning that does not have equivalent representations in other cultures. Combining ai systems with human review will enhance the accuracy of translations while preserving cultural context [24].

4.5 visual analysis using computer vision for documenting ritual activity & procession movements

Computer vision enables ai systems to analyse visual information contained in images and videos. In the field of cultural heritage documentation, computer vision can aid in identifying objects, activities, movement patterns and trends in cultural events.

Using computer vision techniques within Mahasu Maharaj rituals/processions will enable the analysis of traditional attire, religious symbols, ceremonial objects, participant activity etc. Image recognition by ai systems will help categorize the various stages of rituals and enable the organization of visual records in Digital archives. Video analysis will also enable documentation of movement trends, participation rates, and traditional performances. These will provide researchers with organized information concerning cultural events along with providing visual references for researchers to consult at a later date.

4.6 organizing cultural resources using ai based classification

Large amounts of multimedia information in Digital cultural archives need to be properly organized so users can find what they want quickly. Ai based classification methods can automatically group cultural resources by content, location, type of event & historical relevance [25].

Machine Learning models can analyse images/audio/video/text documents and place each resource into one or multiple categories that exist in cultural repositories. Users will be able to retrieve information more quickly using a well-organized archive.

In addition to organizing Mahasu Maharaj heritage documentation resources concerning rituals/festivals/oral narratives/traditional music/processions/etc., ai based classification will greatly reduce user management tasks needed for long term preservation.

4.7 Machine Learning methodologies for analysing cultural patterns

Machine Learning methodologies can identify patterns and relationships between data points in large cultural datasets. These methodologies can analyse repeating elements in stories; similar aspects between rituals; and changing cultural behaviours overtime.

Machine Learning can aid researchers who study cultural events by analysing factors such as participation behaviour; sequence order of ritual; relationship between cultural items; etc.

Therefore, Machine Learning can provide researchers with new insights into how cultural traditions continue to evolve generationally while respecting the interpretations provided by communities.

Artificial intelligence provides several tools for preserving and analysing cultural heritage through natural language processing; visual analysis; automatic classification; and pattern recognition. When employed thoughtfully; ai can facilitate the development of Digital documentation of Mahasu Maharaj traditions by making it easier to collect/document/organize/call-up/access cultural knowledge while honouring community involvement [26].

5. ROLE OF IOT IN CULTURAL HERITAGE MONITORING AND DOCUMENTATION

5.1 Concept of IoT-Based Cultural Documentation Systems

The Internet of Things (IoT) is a new method for documenting cultural heritage because it allows the creation of inter-related and autonomous tools to capture, send and manage the data of culture in real time. Cultural documentation using IoT technology consists of smart sensor networks, communication networks, cameras and smart devices which capture data relating to cultural events, traditional practice and cultural activity.

Traditional forms of documentation are mostly dependent upon manual recording; therefore, they have limitations in terms of continuous and automatic data collection. In contrast to these forms of documentation, IoT based systems will continuously capture data regarding cultural events via a networked system of devices. This is especially useful when capturing dynamic cultural events like processions and rituals [27].

Furthermore, IoT technologies offer great potential for documenting the activities of Mahasu Maharaj tradition by providing the means to document ceremonial processes ions, performances and environmental condition related to cultural event. In addition, the data captured via IoT technologies can be added to digital archives so that the recorded cultural heritage can be documented in a structured and easily-accessible manner.

5.2 Real-Time IoT Enabled Data Capture at Cultural Event Sites

IoT technologies allow for the capture of real-time cultural information by deploying sensors and other connected devices throughout the location(s) where heritage events take place. Examples of IoT enabled technologies include smart camera's, audio sensors, wearable tracking devises and location tracking devises capable of capturing performance, rituals, participants movements, etc.

During Mahasu Maharaj celebrations, IoT enabled technologies can collect multimedia types of data such as audio/video recordings of traditional music/songs/rhythms and video recordings of rituals. In comparison to manually recorded data, this

continuous flow of information creates a rich and complete picture of the cultural practices of Mahasu Maharaj. In addition to creating a better understanding of cultural practices, IoT enabled systems allow for synchronization of information gathered from multiple connected devices. This integration creates a more accurate and comprehensive digital record of cultural heritage than if each device were to gather its own independent information [28].

5.3 Smart Sensor Technology for Geographical/Location Monitoring and Environmental Monitoring

Smart sensors used in IoT enabled systems contribute to monitoring both geographical and environmental factors during cultural activities. Parameters measured by these sensors include temperature, humidity, location and surrounding environment conditions.

Environmental monitoring contributes to the long-term preservation of cultural artifacts, traditional items and heritages sites by maintaining historical records of environmental conditions that could potentially threaten or damage them. Similarly, location-based monitoring (e.g., via GPS devices), provides valuable information on route paths taken during cultural events, procession routes, movement patterns etc.

For example, in regards to the procession routes taken by participants in Mahasu Maharaj procession routes, location monitoring can help identify the traditional procession routes, community participation areas and geographically connected cultural site. Additionally, location monitoring information can be used to develop maps and analyse the cultural practices associated with those cultural sites [29].

5.4 Wearable and Portable Devices for Documenting Rituals

Wearable and portable IoT technologies provide flexible ways to document cultural activities without disrupting or altering the traditional nature of those activities. Examples of wearable/portable devices include wearable cameras, smart audio recorders and portable sensing devices.

Examples of how wearable/portable devices can be used to document cultural activities include using wearable cameras to record from a first-person perspective during rituals/ceremonies. Similarly, smart audio recorders can be used to record the sounds of rituals/ceremonies while portable sensors can capture data on various parameters.

These wearable/portable devices enable researchers'/community members to document their experiences during cultural events from diverse vantage points while allowing them to maintain their physical mobility during the event. Using wearable devices to record details about ritual sequences/traditional performances/participant interaction will enhance our knowledge base about Mahasu Maharaj tradition.

6. PROPOSED AI-IOT-BASED FRAMEWORK FOR MAHASU MAHARAJ CULTURAL DOCUMENTATION

The purpose of the proposed AI-IoT based framework is to create a systematic approach for the digital documentation, preservation and analysis of Mahasu Maharaj's cultural traditions in Uttarakhand. Cultural practices such as oral narratives, ceremonies, processions and rituals are often complex and contain large amounts of social and historical information. Therefore, they require more sophisticated tools for recording and managing them. In order to achieve these objectives, the proposed framework utilizes Internet of Things (IoT) technology to obtain real time cultural data and Artificial Intelligence (AI) for analysing and organizing the obtained cultural information.

The framework has five distinct layers. The first layer is the cultural data acquisition layer; the second is the IoT-based sensing and recording layer; the third is the AI-based processing and analysis layer; the fourth is the digital cultural repository layer; and the fifth is the user interaction and access layer. Each of these layers allows for continuous collection, intelligent analysis, and secure preservation of cultural resources while promoting community participation and cultural authenticity.

6.1 General Overview of the Proposed Digital Documentation Framework

The general overview of the proposed digital documentation framework demonstrates how it will document Mahasu Maharaj's cultural traditions via interconnected sensor technologies, coupled with intelligent data analysis. The framework captures all forms of cultural information, such as oral histories, traditional music, ritual activity, procession movements, and community practices.

The process begins at the cultural data acquisition level. At this point, cultural information is gathered from community members, cultural specialists, and heritage events. Once this information is obtained, IoT enabled devices record real time video, audio, location and environmental data as well as other relevant information as part of the cultural activity. The recorded data is analysed using various AI techniques, such as natural language processing, computer vision, and machine learning to identify significant cultural patterns [30].

Once the analysed information is created, it is placed into a digital cultural repository where multimedia items (such as oral histories, ritual videos, traditional music, photos, etc.) can be organized/created/maintained and accessed by researchers, communities, educational platforms, etc. The framework supports continuous communication between IoT devices/AI systems/digital archive platforms to ensure that cultural knowledge continues to be preserved over time.

6.2 Cultural Data Acquisition Layer

The primary responsibility of the cultural data acquisition layer is to gather raw cultural information from numerous different source points related to Mahasu Maharaj's traditions. Community interviews/oral histories/historical documents/routine observation/traditional music/procession documentation are examples of some of the sources included in this category. Community members/cultural specialists/experts who have been raised in their culture are considered very important contributors of indigenous knowledge. They share their experiences/explanations on what the cultural practice means/history/significance. Examples of types of data collected include: text/audio/image/video. The main objective of this layer is to capture both physical/tangible and non-physical/intangible elements of culture for eventual digital processing.

6.3 IoT-Based Sensing and Recording Layer

The primary function of the IoT-based sensing and recording layer is to automatically document cultural activities in real time through use of inter-connected devices. Through use of IoT sensors/smart cameras/wearable devices/portable recording equipment cultural activities are documented during a variety of different events such as festivals/rituals/ceremonies/processions. Audio sensors may collect traditional songs/religious chanting/narratives. Smart cameras may collect images of clothing/object/performances during rituals/ceremonies. GPS-enabled devices may track procession routes and locations during festivals/events. Environmental sensors may collect data about cultural locations by tracking climate parameters such as temperature/humidity. Collected data may be transmitted securely to analytical systems for subsequent analysis.

6.4 AI-Based Processing and Analysis Layer

The AI-based processing and analysis layer transforms collected cultural data into usable digital knowledge. A number of AI techniques can be utilized to analyse different types of cultural information.

Natural Language Processing (NLP) methods can be employed to analyse oral histories by transcribing spoken words into written text/textualizing speech/extracting central themes/preserving local dialectical usage. Speech recognition models can aid in documenting traditional storytelling/community dialogues.

Computer Vision methods can be used to analyse images/videos of rituals/processions by extracting object/activity/participant movement characteristics. Machine Learning algorithms can categorize cultural assets/find patterns among diverse traditions. Intelligent organization/interpretation of cultural information will be supported by this layer. Additionally, researchers will be able to comprehend cultural patterns [31].

6.5 Digital Cultural Repository Layer

The digital cultural repository layer provides secure storage and management of documented cultural resources. Multimedia records (oral histories/videos/music/images/descriptions) are stored within this repository.

Metadata Management is used to organize cultural resources by categories such as event type/location/historic significance/community affiliation. Accessibility will improve/retrieval efficiency will increase.

Long-term preservation is provided by the repository for digital records of Mahasu Maharaj's traditions for future generations. Authentication and controlled access security mechanisms ensure protection for culturally sensitive information.

6.6 User Interaction and Access Layer

The user interaction and access layer provides interfaces through which various users can access digital cultural resources. Researchers/community members/educational institutions/cultural organizations will be able to engage with the repository through web/mobile platforms.

Users will be able to browse documented narratives/view ritual recordings/analyse cultural resources/access historic records. Educational platforms can utilize interactive components to demonstrate digital representations of traditional practices.

Community involvement can be integrated into this layer; community specialists will be able to add additional information/document validity for each item.

6.7 Communication Among IoT Devices/AI Systems/Digital Archive Platforms

Continuous documentation of cultural knowledge relies upon effective communication between IoT devices/AI processing platforms/digital repositories. IoT devices transmit collected data through communication networks to AI-based processing platforms. Processed information generated by AI systems is then stored within the digital repository. Users will subsequently have access to organized digital resources via digital platforms.

Communication protocols are necessary to safeguard cultural information during transmission. Encryption/authentication/controlled access are mechanisms that will ensure that digital heritage materials are properly secured while enabling responsible dissemination/sharing.

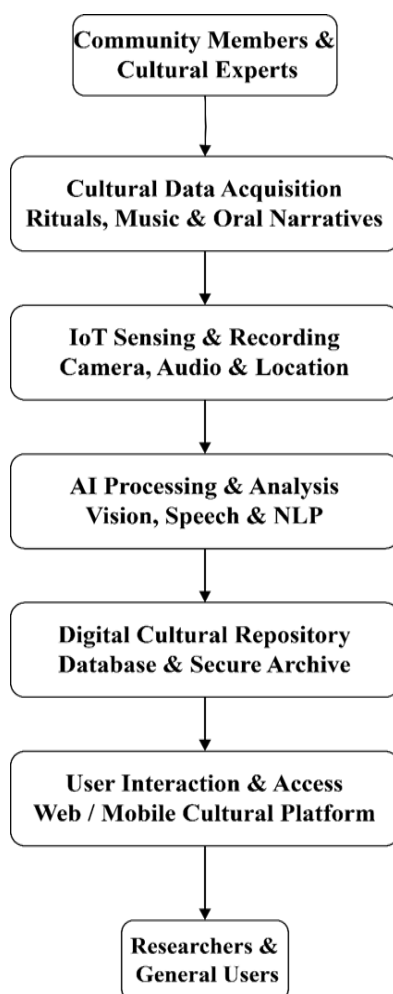


Figure 1: Architecture of AI and IoT-Based Digital Documentation Framework for Mahasu Maharaj Cultural Heritage Preservation

The proposed AI-Internet of Things (IoT) framework illustrated in Figure 1 has been designed as an application to document and preserve traditional practices of Mahasu Maharaj. This framework includes a number of layers that include:

- a. Cultural data collection through IoT enabled sensors which are collecting real time information on the performance of rituals; and the documentation of stories or narratives told during the celebrations; and procession routes etc.
- b. Using Artificial Intelligence (AI), the collected cultural data is organised and analysed.
- c. Digital Repository – A secure environment for storing cultural data, so it can be accessed by Researchers, Communities and Educational Platforms etc.

7. DIGITAL DOCUMENTATION OF CULTURAL NARRATIVES

7.1 Collection of Oral Histories and Traditional Stories

Beginning with the ways that oral histories and traditional stories are part of a culture's "intangible cultural heritage," these types of narratives are important in helping to pass along history, religious beliefs, a community's experiences, and its values. The transfer of this type of cultural knowledge is typically done through storytelling, which is usually performed by an elder, a member of a community who has been recognized for their spiritual or religious role within a community, or other knowledgeable members of a community. While performing these acts of storytelling, these individuals convey various pieces of information, including how a tradition was originated; what the purpose of a ritual is; whether there were historical events associated with the performance of certain rituals; and if there exists a connection between different communities and the practice of a particular cultural tradition [31].

Collecting oral narratives includes taking audio and/or video records of conversations, interviews, and storytelling sessions conducted with knowledgeable individuals. Individuals who possess traditional knowledge will typically serve as a primary source when it comes to collecting and documenting traditional knowledge. Collecting these narratives systematically can help keep intact information that could potentially disappear over time due to generationally based changes in the way people practice their cultures; the movement of populations; and the loss of interest in practicing traditional customs.

Documenting oral histories digitally preserves them in the exact same manner in which they existed prior to being digitized; however, also provides an opportunity to analyse the material contained within them using advanced technologies. Digital documentation allows for the ability to create both audio and video records, thus providing further contextualization of the information being conveyed through the use of the speaker's/performer's language style, facial expressions and body movements; etc., that are involved in telling the story [33].

7.2 Effective Methods for Documenting Community Narratives

To document community narratives appropriately while retaining cultural integrity requires effective methods of documentation. Using high-quality audio recorders, video cameras and portable digital recording devices allows researchers to collect both verbal and non-verbal forms of expression associated with storytelling. Field based documentation methods include conducting structured interviews with cultural practitioners, participating in observing the performances of cultural practitioners, and engaging in community discussions. Conducting interviews with cultural practitioners provides detailed information regarding the rituals, historical events and beliefs surrounding those events. Video documentation serves to preserve visual representations such as hand gestures, traditional clothing and cultural settings. IoT enabled recording devices can enhance documentation efforts through the ability to continuously and in real-time collect data. Portable sensor technology and smart recording systems can document cultural narratives during community celebrations, festivals and ceremonial events while reducing limitations associated with manually collecting data.

Maintaining ethical standards is critical when collecting narratives. It is essential to obtain permission from the community before collecting narratives, to demonstrate sensitivity towards the culture represented in the narrative being collected, and to properly acknowledge those contributing their knowledge so that it can be documented respectfully.

7.3 Advanced Technologies Utilizing Artificial Intelligence for Speech Recognition and Transcription

Using artificial intelligence-based speech recognition technologies provides researchers with advanced tools that enable automatic transcription of recorded oral narratives into organized digital formats. Speech recognition models can take an audio

file containing oral storytelling and produce a machine generated transcript. For example, AI-based speech processing can facilitate the documentation of Mahasu Maharaj traditions by analysing local dialects and regional expressions that have minimal to no written documentation available. In addition to facilitating faster processing times than manually transcribing audio files into text format, automated transcription enables researchers to focus on higher-level analytical tasks such as analysing transcriptions using Natural Language Processing (NLP) [32].

Automated NLP can identify key concepts, references to specific cultural traditions, and repetitive themes throughout individual narratives. However, developing AI-based language models specifically tailored to each region and language can aid in improving transcription accuracy and preserving linguistic features that distinguish one local language/dialect from another.

8. AI-BASED ANALYSIS OF RITUALS AND PROCESSIONS

8.1 Computer Vision-Based Analysis of Ritual Activities

Computer vision is a key technology in Artificial Intelligence that enables machines to process and interpret visual information from digital images and video recordings.

In cultural heritage documentation computer vision techniques can assist analysis of complex ritual activities by identifying visual patterns and objects in movement within cultural events.

Mahasu Maharaj traditions are performed through multiple types of activity such as ceremonial practices, religious performances, traditional gatherings and symbolic actions. Manual analysis of these event situations can be time consuming and may not capture all details. AI-based computer vision systems will enable recording of videos and images of rituals to classify them into structured digital recognition records.

Deep learning models using CNN's (Convolutional Neural Networks) have been successfully used for analysing visual features in cultural recordings. Deep learning models assist researchers to classify ritual sequence order, participant action and important cultural elements while preserving the visual component of traditional practices [34].

8.2 classification of Traditional Costumes, objects and symbols

Traditional clothing and accessories, objects and symbols which have religious or social significance represent very important parts of the culture.

AI-based image classification techniques will help automatically detect and classify these elements in digital recordings.

During Mahasu Maharaj rituals and processions participants wear traditional dress, use ceremonial objects, religious symbols and cultural artifacts which have historical and society significance. Computer vision models will detect these items and link them with their corresponding cultural information stored in digital archives.

Object recognition systems provide accurate description of material aspect of intangible cultural heritage by binding visual data with metadata like meaning, context and history of use. This supports better indexing and preservation of material aspect of intangible cultural heritage.

9. CHALLENGES AND LIMITATIONS

9.1 Cultural Sensitivity and Community Consent

Digital documentation of cultural heritage must take into account the cultural values and beliefs of a community and their expectations. For example, documenting some cultural practices, like the Mahasu Maharaj rituals, includes sacred community knowledge that would be unethical to document or share if it was done so improperly.

Participation by the community and their permission will help make sure that documentation occurs properly and does not disrespect the local culture. In order to establish what information should be able to be recorded, stored and made publicly accessible, researchers and technologists need to work closely with community members (practitioners), religious authorities and local leaders.

If culturally insensitive documentation occurs, there could be an improper representation of the traditional knowledge or even a mis-use of it. Therefore, proper documentation methods and community involvement is needed to responsibly preserve cultural heritage [35].

9.2 The Difficulty in Accurately Interpreting Traditional Practices Using Artificial Intelligence

Using artificial intelligence provides many opportunities to analyse cultural data; however, using AI to interpret traditional practices still presents numerous challenges. AI models recognize patterns in existing datasets. As mentioned above, they do not necessarily understand the deeper symbolic, spiritual or historical significance behind these patterns.

As previously stated, some of the rituals of the Mahasu Maharaj tradition along with various aspects of this tradition's expression may hold very specific meanings within their own community. Due to this specificity, automated analyses may not capture all of these meanings. Additionally, AI-based classification systems may mis-identify cultural activities or fail to consider important contextual information about these activities.

Therefore, due to the limitations of AI alone to provide complete understanding, human expert validation from researchers and cultural practitioners is required for the accuracy and relevance of the results generated by AI. Furthermore, combining human knowledge with AI-driven analysis increases the likelihood of providing accurate and relevant documentation.

9.3 Difficulties in Capturing Oral Tradition Digitally

The difficulty in capturing oral traditions lies in the fact that cultural knowledge is typically passed down through stories (oral narratives) and local languages. Similar to written records, oral narrative can vary depending upon individual storytellers and generations.

Capturing oral traditions digitally involves more than just recording the spoken word. It also means capturing the cultural context surrounding the story telling including expressions and meanings that accompany storytelling. Regional language variations and differences in local dialects can create barriers for digital documentation. Also, obtaining sufficient language resources for translation purposes can create additional barriers.

Currently, speech-to-text software used for speech recognition and transcription has difficulties recognizing regional languages and expressions typical of indigenous cultures. Continual communication with native speakers and cultural experts is critical for maintaining authenticity during the process of creating digital documentation.

10. FUTURE PROSPECTS OF AI AND IOT-BASED CULTURAL PRESERVATION

10.1 AI-Driven Cultural Knowledge Systems

Artificial intelligence will be used to develop systems for the preservation and management of the world's cultural heritage. These systems will include all of our cultural artifacts (oral histories, rituals, songs, documents, and community practices) integrated into a single digital platform.

The use of artificial intelligence technologies like natural language processing, machine learning and knowledge graphs to manage large amounts of cultural information will enable these systems to find relationships among various cultural components and increase access to this information. The AI systems that will manage Mahasu Maharaj traditions can associate stories, rituals, festivals, objects, and historical information in one database to facilitate an organized way of managing the vast amount of information available.

In addition to supporting the organization of information, future AI systems can assist in automatically interpreting, recommending, and retrieving cultural information. This can allow researchers, students, and individuals who are interested in studying their own community's cultural history to engage with the information they seek while at the same time maintaining contact with the original source of the knowledge [35].

10.2 Virtual and Augmented Reality – Based Cultural Experiences

Virtual reality and augmented reality technology provide new possibilities for developing immersive cultural experiences. Both technologies have been successfully applied to recreate cultural environments, rituals, and historical locations virtually; therefore, people can now participate in experiencing cultures remotely without physically being present.

With respect to Mahasu Maharaj traditions, virtual reality environments can simulate temple visits, ceremonies, and processions. Similarly, augmented reality applications can provide additional layers of cultural context to actual places where they exist. Individuals can view examples of traditional objects, understand the symbolism behind specific rituals, and experience cultural events through interactive digital environments provided by both types of technologies.

These technologies offer potential benefits for preserving cultural education because they can offer younger generations and global audiences' new methods of understanding Himalayan traditions. Immersive technologies can also assist in preserving cultural practices that may eventually become difficult to practice due to travel constraints [36].

10.3 Digital Twin Technology for Preserving Cultural Events and Processions

Digital twin technology is a means of creating a virtual model of a physical environment, event, or activity. Digital twin technology has several applications in cultural preservation including simulating temples, documenting heritage sites and events, representing rituals and processions using sensor data in real-time.

A digital twin of a Mahasu Maharaj procession would provide an example application that combines data collected from sensors located along the route travelled during the procession (including images), participant movements and documented historical records to provide a comprehensive model of a significant cultural event.

Digital twins have the ability to preserve cultural activities. Using digital twins' researchers can analyse how traditions evolve over time. Communities can document important cultural events using digital twins and keep those records on file for later reference [36].

11. CONCLUSION

Cultural Heritage Preservation is an activity that necessitates systematic methodologies to record, organize, and allow access to traditional knowledge (TK) and maintain its credibility and importance to the culture. In this paper, we propose an AI-IoT based methodology for the digital documentation and preservation of Mahasu Maharaj traditions in Uttarakhand. It will combine the data collection of cultural data; the recordings of the cultural data via Internet-of-Things (IoT); the processing and analyses of the cultural data via Artificial Intelligence (AI); management of the Digital Cultural Repository; and User Interaction Layers to create a structural method for the preservation of cultural heritage. The proposed methodology will enable the collection of a wide variety of cultural resources from various types of resources (oral stories/narratives, music, rituals, ceremonies, processions) through community participation and utilizing IoT technology. Techniques within AI (Natural Language Processing (NLP), Speech Recognition, Computer Vision, Machine Learning) will be utilized to organize, analyse, and interpret cultural information. The digital repository layer will ensure safe storing; organization via metadata; controlled access to preserve valuable TK for future generations. This study has shown that AI/IoT technology may aid in the digital preservation of heritage by providing better accuracy, accessibility, and management of knowledge in documenting cultural heritage. For AI/IoT technology to successfully implement the digital preservation of heritage there are several requirements: active community engagement in participating in the implementation; respect for cultural values; and protecting culturally sensitive information. The proposed methodology is a basis for further research on digital heritage initiatives and can also serve as a resource for education and sustainability in preserving indigenous cultural traditions.

AUTHOR CONTRIBUTIONS

Santosh: Conceptualization, Investigation, Formal Analysis.

Dr. Anita Goswami: Methodology, Laboratory Analysis, Supervision, Writing—Review & Editing.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

Ethical approval was not required for this study.

REFERENCES

- [1] Ahmed, B., 2025. EAIFFCH-Ethical-Framework-for-Cultural-Heritage. *Open Science Framework*.
- [2] Barbudo, C., Lais, E.T., Saraiva, C., Gregorio, V.S.A.B., 2025. Soberania e governança de dados de povos indígenas em tempos de Inteligência Artificial Generativa. *Publications (Mid Sweden University)*.
- [3] Bari, M.D., 2026. Artificial Intelligence and Eco-Museums: Climatic Challenges and Ethical Perspectives within European Cultural Sustainability. *IntechOpen eBooks*. IntechOpen.
- [4] Bhimavarapu, U., 2025. AI-Driven Indigenous Knowledge Management Ensuring Ethical Accessibility, 25–48.
- [5] Carroll, S.R., Herczog, E., Hudson, M., Russell, K., Stall, S., 2021. Operationalizing the CARE and FAIR Principles for Indigenous Data Futures. *Scientific Data* 8(1), 108.
- [6] Chigwada, J.P., Mapara, J., Ngulube, P., Chabvutagondo, T., 2025. Influence of Indigenous Data Governance Principles on Indigenous Knowledge Management: Lessons from the Southern African Intangible Cultural Heritage Project. *IFLA Journal* 52(1), 38–47.
- [7] Crouzet, L., Pöllinger, A.L., Langenberg, S., 2025. Craft and Repair Heritage: From Capture to Dissemination in Digital Space. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 367–374.
- [8] Fu, Y., Shi, K., Xi, L., 2025. Artificial Intelligence and Machine Learning in the Preservation and Innovation of Intangible Cultural Heritage: Ethical Considerations and Design Frameworks. *Digital Scholarship in the Humanities* 40(2), 487–508.
- [9] Geng, S., Yan, S., Chau, H.-W., Jamei, E., Vrcelj, Z., 2025. From Data to Cultural Response: A Machine Learning–Driven Digital Twin Model for Smart Heritage Precincts in Urban Context. *Journal of Information Technology in Construction*, 1314.
- [10] Green, B.J., Kamenarac, O., Jandrić, P., 2026. Postdigital War and Peace. *Postdigital Science and Education*.
- [11] Hou, Y., Kenderdine, S., Picca, D., Egloff, M., Adamou, A., 2022. Digitizing Intangible Cultural Heritage Embodied: State of the Art. *Journal on Computing and Cultural Heritage* 15(3), 1–20.
- [12] Kuranga, C., Masenya, T.M., 2025. Decolonizing Digital Technologies for Indigenous Knowledge Systems, 1–6.
- [13] Mbah, M.F., Jarvis, L., 2026. Towards a Decolonial AI Sovereignty Model for Indigenous Educational Settings. *Cogent Education* 13(1).
- [14] McDougall, A., Gerardo, H., 2025. Hybrid Human-AI Systems for Preserving Cultural Heritage and Craftsmanship. *Frontiers in Artificial Intelligence and Applications*.
- [15] Mir, A.S., 2026. What is Worth Preserving in Digital Archiving? Community, Consent and an Exploration of the Psychology of. *International Journal of Social Science Research and Review* 9(1), 440–456.
- [16] Odeke, L.W., Kirui, A.K., 2025. Reclaiming the Sonic Archive: AI, Data Sovereignty, and the Future of Mijikenda Music. *Journal of Visual and Performing Arts* 3(1), 53–62.
- [17] Olayinka, O.T., Temitope, O.I., Thomas, A., Oluwole, A.P., 2025. Co-Designing Ethical AI with Faith Communities: Advancing Worship Innovation, Moral Governance, and Resilient Digital Ecosystems. *African Multidisciplinary Journal of Sciences and Artificial Intelligence* 2(3), 546–565.
- [18] Palladino, C., Bodard, G., 2023. Can't Touch This: Digital Approaches to Materiality in Cultural Heritage. *Ubiquity Press eBooks*. Ubiquity Press.
- [19] Perwitasari, I.D., Ariffin, S.A., Hendrawan, J., 2025. A Theory-Informed Conceptual Framework for Sustainable Intangible Cultural Heritage Preservation in the Digital Era through Immersive Information Systems. *Proceedings of the International Conference on Computer Science Engineering Social Science and Multi-Disciplinary Studies* 1, 11–21.
- [20] Ray, S., Ray, R.L., 2026. Incorporating Indigenous Knowledge Systems into AI Governance: Enhancing Ethical Frameworks with Maori and Navajo Perspectives. *AI and Ethics* 6(1).

- [21] Ren, K., Lam, J.F.I., 2026. Knowledge Graph-Driven Digital Preservation of Intangible Cultural Heritage: A Cross-Cultural Comparative Study of Chinese and Western Implementation Paradigms. *Humanities and Social Sciences Communications* 13(1).
- [22] Rouhani, B., 2023. Ethically Digital: Contested Cultural Heritage in Digital Context. *Indiana Magazine of History* 7(1), 1–16.
- [23] Salah, M., 2026. Algorithmic Memory: Towards Reflexive Authenticity in Cultural Heritage. *AI & Antiquity*, 65–75.
- [24] Shani, R., R, R., 2026a. Digitising Indigenous Knowledge: Nilgiri Tribes and the Posthuman Future of Cultural Preservation. *International Journal of Research in English* 8(3), 44–45.
- [25] Shani, R., R, R., 2026b. Digitising Indigenous Knowledge: Nilgiri Tribes and the Posthuman Future of Cultural Preservation. *International Journal of Research in English* 8(3), 183–184.
- [26] Siyu, H., 2025. Value, Challenge and Strategy: Research on the Digital Revitalization of Intangible Cultural Heritage Traditional Dance. *Research on Literary and Art Development* 6(5), 207–211.
- [27] Soren, S., Kipgen, M., 2025. Illustrating the Intangible Cultural Heritage of Santhals and Kuki: Pushing the Boundaries of Knowledge Sharing in the Era of Technology. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 1413–1419.
- [28] Sousa, N.M.T., 2026. The Algorithm of Silence: Artificial Intelligence, Archival Bias and the Ethical Reconstruction of Digital Memory. *Journal of Documentation* 82(2), 233–248.
- [29] Struensee, S. von., 2021. The Role of Social Movements, Coalitions, and Workers in Resisting Harmful Artificial Intelligence and Contributing to the Development of Responsible AI. *arXiv (Cornell University)*.
- [30] Sun, J., Khalid, K.A.T., Kay, C.S., 2025. Deep Learning Models for Cultural Pattern Recognition: Preserving Intangible Heritage of Li Ethnic Subgroups through Intelligent Documentation Systems. *Future Technology* 4(3), 119–137.
- [31] Tan, Y.-C., Yang, L.-H., Wang, B., 2026. Community-Engaged Digital Safeguarding of Intangible Cultural Heritage: A Review of Methods and Challenges. *npj Heritage Science* 14(1).
- [32] Wu, S., 2025. AI and Intangible Heritage: Exploring Sustainable Cultural Transmission Through a Dual-Framework Approach. *Applied and Computational Engineering* 164(1), 8–19.
- [33] Zhang, D., 2025. Artificial Intelligence for the Preservation and Transmission of Non-Material Cultural Heritage: Opportunities, Ethical Challenges, and Future Directions. *Applied and Computational Engineering* 174(1), 214–220.
- [34] Zhang, L.Q., Wang, Z., Yang, R., Yi, Q., 2025. Digital Presentation and Interactive Learning for Intangible Cultural Heritage Preservation Using Artificial Intelligence. *IEEE Access* 13, 126245–126260.
- [35] Zhao, J., Chen, X., 2025. Digital Preservation of Intangible Cultural Heritage Empowered by Blockchain Through Distributed Storage and Dynamic Traceability Algorithm Research. *International Journal of High Speed Electronics and Systems*.
- [36] Zhou, X.Y., 2025. Reviving Craft Traditions With AI and Tech. *International Journal of Agricultural and Environmental Information Systems* 16(1), 1–14.