DRONE APPLICATION FOR RELIGIOUS MANAGEMENT PLANNING PURPOSES: A SYSTEMATIC REVIEW

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ABSTRACT: This systematic review paper aims to comprehensively investigate the applications of drones in religious management planning. Drone studies are very likely to develop more, with their growth potential to provide a higher resolution photo as compared to satellite imaginary mapping. Throughout the year, drones had been widely used in various fields with their capability to not only produce a clearer image of the site but the data captured can also be processed into point clouds and Digital Elevation Model (DEM) for further analysis. Religious management should benefit from this technology by integrating the use of drone mapping and GIS systems to allocate resources such as religious buildings, cemeteries, and religious schools. The purpose of this review is to identify and synthesize existing research studies on drone mapping in the context of religious management by examining recent literature, drone techniques, data processing methodologies, practical implementations, as well as limitations. The study seeks to gain valuable insights into the diverse applications of drones for religious building allocation, cemetery management, and other religious infrastructure planning. A systematic search strategy is conducted across multiple academic databases, including ScienceDirect, Scopus, and IEEE Xplore, to identify relevant peer-reviewed studies published between 2018 and 2023. Keywords are utilized to ensure the inclusion of all relevant literature. The synthesis of the findings summarizing the key themes, trends, and applications of drone technology in religious management planning, presented in a structured manner, offers insights into the effectiveness, challenges, and future prospects of using drones for optimizing religious management processes. The findings of this review contribute to a deeper understanding of the potential benefits and limitations of drone technology in religious contexts, offering evidence-based recommendations for enhancing future research and practical implementations.

1. INTRODUCTION

In an era marked by remarkable technological advancements, the integration of Unmanned Aerial Vehicles (UAVs), commonly known as drones, has transcended traditional boundaries and found applications in diverse domains. One such realm that needs to embrace this transformative technology is religious management planning. Drones offer a unique vantage point from the skies, capturing high-resolution imagery and providing invaluable data for decision-making processes in the context of religious institutions, including churches, temples, mosques, synagogues, cemeteries, and religious schools. Religious institutions, like many other sectors, face the challenge of managing their physical resources effectively (Marshall, K, 2021, Tan. M et al., 2022). From assessing the condition of religious structures to optimizing cemetery land usage, the precise and comprehensive data offered by drones has become indispensable. These resources encompass a broad spectrum, including but not limited to, physical structures (such as churches, temples, mosques, and educational facilities), land and properties, historical artifacts, archives, and cemeteries. Efficient management of these resources is crucial for the seamless functioning of the institution, meeting the needs of the community, and preserving the cultural and historical heritage associated with the religion.

The integration of modern technologies, such as drones and Geographic Information Systems (GIS), is gradually being recognized as a powerful tool to aid in resource management for many planning matters, which includes on religious institutions matters as well. As drones can provide detailed aerial views and data, aiding in the assessment of physical infrastructure and land usage, GIS, on the other hand. can assist in spatial analysis and data inventory to ensure optimal land planning and infrastructure development (Yoonjo C, 2021). By harnessing these two technologies alongside the rapid growth of the Internet of Things (IoT), religious management planners can make informed decisions regarding resource allocation, infrastructure maintenance, and future development.

This systematic review paper delves into the burgeoning field of drone applications for religious management planning purposes. With a commitment to rigor and objectivity to embark on a journey in exploring the existing body of literature on this subject. The objective is to synthesize the wealth of knowledge that has emerged over the years, shedding light on the multifaceted ways in which drones have impacted religious institutions. Through a systematic and comprehensive review of relevant studies, this paper aims to not only provide a panoramic view of the current state of drone applications in religious management planning but also to discern the promising trends and potential future directions for this dynamic field. Ultimately, in hope that this review will serve as a valuable resource for researchers, practitioners, and policymakers seeking to leverage drone technology for the enhancement of religious institutions and their vital roles in the communities.

2. METHODOLOGY

The review procedure is being carried out to thoroughly investigate the use of drones in religious management planning as its main study topic. The objective of this systematic review is to systematically gather, evaluate, and synthesise the body of information already available on drone applications in religious settings. To systematically gather pertinent data from each chosen study, a standardised data extraction form was created. Study design, research goals, methodology, significant findings, and restrictions were all included in the data extraction. The reviewer independently extracted the data to ensure accuracy and consistency. The results of the chosen studies were combined using a narrative method. This required searching the data for significant themes, trends, and patterns. The findings are organised and presented to give a thorough overview of drone applications in religious management planning as they stand right now. This review aims to provide a thorough, objective, and evidence-based analysis of drone applications in religious management planning by employing a systematic methodology. This analysis offers insightful contributions to academic study as well as real-world applications in the dynamic and developing field of religious management.

The review process is conducted to comprehensively explore the applications of drones in religious management planning as its main study topic. The methodology for this systematic review study is designed to collect, assess, and synthesize the existing body of knowledge on drone applications in religious contexts systematically. To ensure accuracy and consistency, data extraction was performed independently by the reviewers. The findings of the selected studies were synthesized using a narrative approach and the results are presented in a structured manner to provide a comprehensive overview of the current state of drone applications in religious management planning. By following this systematic methodology, this review seeks to provide a robust, unbiased, and evidence-based analysis of drone applications in religious management planning. This analysis contributes valuable insights to both academic research and practical applications in the dynamic and evolving field of religious management.

2.1 Systematic literature review and content analysis

2.1.1 Document search

A rigorous search strategy was implemented to identify relevant literature. By conducting extensive searches across multiple academic databases, including ScienceDirect, Scopus, and IEEE Xplore databases, the search terms were carefully selected to capture studies related to drone technology and its utilization in religious management planning. Keywords such as "drone," "UAV," "religious management," "cemetery mapping," "GIS," and variations thereof were employed.

2.1.2 Inclusion and exclusion criteria

For this literature review. included studies needed to focus on drone applications in religious contexts, be published in English, and fall within the time frame of 2018 to 2023. Eligible study types encompassed peer-reviewed journal articles, conference papers, reports, and relevant gray literature. Studies not directly related to the use of drones in religious management planning were excluded. Two independent reviewers conducted the initial screening of titles and abstracts to identify potentially relevant studies. Full-text articles from selected studies were then retrieved and reviewed to assess their eligibility based on the predefined inclusion and exclusion criteria. Any disagreements regarding study selection were resolved through consultation, discussion and consensus.

2.1.3 Categorization of document

The primary aim of this systematic review is to organize findings from chosen studies based on their specific subjects. This classification is pivotal as it offers a structured approach to presenting results, enhancing comprehension regarding the various applications of drone technology in religious management planning. In the data extraction stage, key insights and findings from each study are gathered, focusing on extracting two main categories: the methods used for processing data and the implementation study areas. To ensure the consistency and accuracy of categorization, two independent reviewers are involved in this process. Any discrepancies or differences in categorization are resolved through discussion

and mutual agreement. This synthesis delivers a clear and comprehensive overview of the diverse applications of drone technology in the realm of religious management.

3. RESULTS

3.1 Category Distribution

3.1.1 Data processing method

A significant focus within this category is placed on the data processing methods. Understanding the distribution of these methods provides valuable insights into the technological approaches utilized in drone applications for religious management planning. Some of the methods include photogrammetry, a computer vision technique that allows the creation of 3D models from 2D images captured. Drones equipped with high-resolution cameras will capture a series of overlapping images of the targeted area, and photogrammetric software processes these images to construct 3D representations. Studies utilizing photogrammetry often emphasized its ability to generate high-resolution models for religious site mapping and visualization. For instance, the study by Liang, H. et al. (2018), explores the integration of various advanced technologies for the documentation of Chinese classical gardens, focusing on Huanxiu Shanzhuang in Suzhou, China. The research aims to demonstrate the efficacy and benefits of integrating terrestrial laser scanning (TLS) and terrestrial and unmanned aerial vehicle (UAV) digital photogrammetry in accurately documenting these intricate garden landscapes.

Meanwhile, a significant portion of the analyzed studies integrated drone-acquired data with Geographic Information Systems (GIS). GIS integration enabled the overlay of drone imagery with spatial data, enhancing the analysis and planning of religious landscapes. GIS provided a powerful tool for mapping, land-use planning, and resource allocation within religious premises. The study by Yoonjo C, et al. (2021), demonstrates how digital technology can enhance the resilience and preservation of cultural heritage. With the proposed use of a "digital cultural heritage cube," which likely refers to a multidimensional digital representation or database of cultural heritage, the concept could involve integrating various types of digital data such as 3D models, images, historical records, and other relevant information into a comprehensive, accessible, and resilient platform. Furthermore, it is found that a notable number of studies incorporated machine learning algorithms and AI techniques for data processing that facilitated automated feature extraction, object recognition, and classification from drone imagery, aiding in efficient mapping and analysis of religious structures and assets.

Many studies also focused on processing point clouds generated from drone-captured images. Point cloud processing involved the extraction of precise 3D coordinates, enabling detailed mapping of religious sites. This method was particularly useful in analyzing the structural integrity and dimensions of religious buildings. Orthomosaic generation was another commonly utilized data processing method. An orthomosaic is a stitched-together image made from multiple drone images, rectified for uniform scale. It provided an accurate, detailed, and georeferenced view of religious sites, supporting spatial analysis and planning.

Understanding the distribution of these data processing methods underscores the versatility and applicability of drone technology in religious management planning. The amalgamation of advanced processing methods showcased the potential of drones in acquiring, analyzing, and utilizing data for effective decision-making in the context of religious institutions. This varied utilization of data processing methods reflects the interdisciplinary nature of employing drones in religious management planning, highlighting the need for integrated approaches to optimize their potential.

3.1.2 Implementation

The categorization into various areas of implementation illuminates the diverse applications of drone technology in the planning of religious management. A notable portion of the studies focused on using drones for infrastructure planning and maintenance within religious institutions. Drones were employed to inspect, monitor, and evaluate the condition of buildings, facilities, and other infrastructure, facilitating efficient maintenance and ensuring the safety and functionality of religious premises. For instance, William, R. et al. (2023) conducted a study on predicting malfunctions in residential septic systems to streamline drone inspections. The objective is to enhance the efficiency and accuracy of inspections by employing predictive models derived from drone-captured high-resolution images, thermal data, and other pertinent information from an aerial perspective, providing valuable insights into the condition and operation of septic systems.

Besides, the preservation of cultural heritage emerged as a prominent domain for drone implementation. Drones played a crucial role in capturing high-resolution imagery and generating 3D models of religious sites, artifacts, and historically or culturally significant structures. This technological approach greatly aided preservation initiatives, documentation processes, and the establishment of virtual archives for the benefit of future generations. Numerous studies notably concentrated on documenting historical religious sites. Drones were instrumental in capturing intricate aerial views and

detailed 3D models, assisting in the documentation and examination of historical sites, including their layouts and architectural transformations. This documentation significantly contributed to historical research and enhanced our understanding of the evolution of religious architecture. For instance, Xiang and team (2019) delved into the 3D digital preservation of expansive ancient Chinese architecture, showcasing a case report that demonstrates the potential and methodology for digitally conserving such monumental architectural heritage. The techniques of 3D digital preservation were employed to meticulously capture and represent large-scale ancient Chinese architecture, creating a comprehensive digital model that replicated the architectural features and complexities of these ancient structures.

Moreover, several studies emphasized the use of drones for data inventory and digitization of religious premises with the integration of GIS to store the data virtually. Drones facilitated the creation of accurate and up-to-date digital inventories of assets, including land, buildings, and other resources. Digitization streamlined record-keeping and supported effective resource management within religious institutions. In addition, drones were widely employed for land use analysis and planning within religious premises. The technology assisted in assessing available land, determining suitable areas for construction or development, and optimizing the use of space to meet the evolving needs of religious communities while adhering to zoning regulations. Some studies also explored the application of drones for environmental monitoring around religious sites. Drones were utilized to assess environmental impact and analyze natural surroundings. This aided in making informed decisions related to environmental conservation and sustainable practices within religious areas.

The focus on the categorization of these areas of implementation showcases the diverse applications of drone technology in the context of religious management planning. Drones not only serve operational and logistical needs but also play a significant role in cultural and historical preservation, aligning with the multifaceted requirements of religious institutions. Integrating drones into these domains contributes to more efficient, informed, and sustainable management of religious premises.

4. DISCUSSION

The discussion section will thoroughly explore the numerous advantages and implications of integrating drone technology within religious institutions. One aspect that deserves focused attention is the potential reduction in the need for manual labor, holding significant implications for the economic and operational facets of religious management. This reduction in manual labor can lead to substantial cost savings and increased operational efficiency for religious institutions, allowing resources to be allocated more effectively towards other crucial areas of development and upkeep. Additionally, automation through drones can enhance the speed and accuracy of various tasks, promoting a streamlined workflow within religious organizations. Overall, embracing drone technology can fundamentally transform the operational landscape of religious institutions, optimizing resource allocation and operational processes.

4.1 Man-power reduction

The reduction in manpower needs can result in significant cost savings for religious institutions. Human labor, especially in tasks involving extensive physical efforts or data collection across large areas, can be resource-intensive. Drones present an efficient alternative, potentially lowering operational costs linked with labor that can handle tasks that would otherwise demand significant human effort. For instance, in cemetery management, drones equipped with high-resolution cameras and mapping capabilities can swiftly survey and map cemetery plots, grave markers, and infrastructure. This expedites data collection and minimizes the requirement for manual labor in physically inspecting and documenting these areas. By reducing the need for manual labor, religious institutions can redirect human resources to more specialized and value-added tasks.

Drones provide a level of data accuracy and consistency that is often challenging to achieve through manual methods. Precise data collected by drones can lead to more informed decision-making in religious management planning, contributing to the overall effectiveness of resource allocation and infrastructure maintenance (Akoglu, K. G. et al., 2020). However, it is crucial to acknowledge that the reduction in man-power through drone technology also raises ethical and societal considerations. Potential job displacement should be carefully managed, and efforts should be made to reskill and redeploy individuals affected by automation. Additionally, the ethical use of technology, including privacy concerns and adherence to regulatory guidelines, should remain paramount. Nevertheless, this transformation should be approached with a balanced perspective, considering both the benefits and the ethical and societal implications, and guided by principles of responsible and sustainable technology adoption within religious institutions.

4.2 Time-saving management/maintenance

The considerable advantages related to time-saving management and maintenance are achieved through the integration of drone technology in religious institutions. The ability to optimize time resources is a critical aspect of enhancing operational efficiency and facilitating more effective religious management planning. Drones equipped with advanced

sensors and imaging technology can swiftly capture high-resolution aerial imagery and data. This rapid data acquisition capability is particularly valuable in scenarios where time sensitivity is paramount, such as assessing the condition of religious buildings, cemeteries, or other infrastructure. The expeditious data collection facilitated by drones allows religious institutions to make more informed and timely decisions. For instance, in the case of emergency situations or the need for urgent repairs, drones can swiftly assess the situation, providing real-time information to guide decision-makers.

Drones contribute to efficient infrastructure maintenance by streamlining the inspection process. Instead of conducting time-consuming manual inspections, drones can quickly assess the condition of buildings, roofs, and other structures, identifying potential maintenance needs before they escalate (Bakirman et al., 2020). In the context of cemetery management, drones offer significant time savings by automating tasks such as plot mapping and grave marker identification. What might have taken weeks or months to accomplish manually can now be completed in a fraction of the time. Time saved through drone-assisted management and maintenance can be reallocated to other critical tasks within religious institutions (Bakirman et al., 2020). This may include pastoral care, community engagement, or strategic planning, enhancing the overall effectiveness of religious management.

Drones enable the efficient documentation and preservation of historical and architectural elements of religious structures. This not only saves time in the documentation process but also ensures that valuable historical information is retained for future generations. While the time-saving benefits of drone technology are substantial, it is essential to consider ethical and regulatory aspects. Privacy concerns, data security, and adherence to local regulations are paramount when employing drones for time-sensitive tasks. Additionally, religious institutions should strike a balance between automation and the human touch, ensuring that the use of technology enhances, rather than replaces, the spiritual and community aspects of their mission. The integration of drone technology in religious management planning significantly contributes to time-saving management and maintenance. This capability not only enhances operational efficiency but also enables religious institutions to allocate their time and resources more strategically, ultimately serving their communities more effectively.

4.3 Sustainable solution/practices

It becomes evident that the incorporation of drone technology brings forth sustainable solutions and practices that hold great promise for religious institutions. The discussion section underscores the multifaceted aspects of sustainability and how drones can contribute to the long-term viability of religious management. Sustainable resource management is a fundamental consideration in religious institutions. Drones assist in optimizing resource allocation by providing precise data on land use, infrastructure conditions, and maintenance needs (Al Tahtawi et al., 2020). This data-driven approach helps reduce resource wastage and fosters sustainable land and facility management. Drones, often powered by clean energy sources, offer a sustainable means of conducting various tasks in religious management. Their reduced carbon footprint, especially when compared to traditional methods that may involve extensive travel, aligns with environmentally responsible practices. Many religious institutions are custodians of historical and architectural heritage. Drones facilitate the preservation of this heritage by providing a non-invasive means of documenting and assessing the condition of religious buildings, artwork, and historical artifacts. This contributes to the long-term sustainability of cultural and religious heritage.

Sustainability often goes hand in hand with economic efficiency. Drones reduce operational costs through time-saving data collection and efficient resource allocation. These economic benefits enhance the financial sustainability of religious institutions, allowing them to allocate resources to community-building and service initiatives. Drones enable evidence-based decision-making in religious management. By collecting accurate and up-to-date data, religious institutions can make informed choices about investments, repairs, and land use, ensuring that their decisions align with sustainable practices. Sustainability extends to the relationship between religious institutions and their communities. Drones can engage the community by involving them in preservation efforts, such as documenting historical features or participating in ecological initiatives. This fosters a sense of ownership and shared responsibility for sustainable practices.

Part of sustainability in religious management involves ethical considerations. Drones can be employed ethically by respecting privacy, adhering to regulations, and ensuring transparency in their use. Ethical practices enhance the credibility and trustworthiness of religious institutions. Drones must comply with evolving regulations in many regions. Integrating drones in a sustainable manner involves staying up to date with these regulations and ensuring that religious management practices align with legal and ethical frameworks.

5. CONCLUSION

This systematic review thoroughly explores how drone technology is transforming religious management planning. Drones have emerged as a game-changing tool with immense potential to revolutionize the management of physical resources within religious institutions, ranging from religious buildings and cemeteries to general infrastructure. The fusion of drone technology with Geographic Information Systems (GIS) has opened up new possibilities for precise data acquisition and well-informed decision-making in the realm of religious institutions. Through this systematic review, a wealth of accumulated knowledge has been synthesized and examined. The existing literature has been thoroughly explored, revealing the diverse ways in which drones are being utilized within religious contexts.

In conclusion, this systematic review underscores the substantial potential of drones in enhancing the efficiency and efficacy of religious management planning. However, to fully realize this potential, there is a pressing need for additional research and collaboration among religious institutions, researchers, and regulatory bodies. Implementing the right strategies and upholding ethical considerations can harness drones' capabilities to contribute to the sustainable management and preservation of religious heritage for generations to come. In summary, this systematic review presents a thorough overview of the current landscape of drone applications in religious management planning. It furnishes valuable insights, pinpoints trends and challenges, and lays the groundwork for future research and practical applications in this ever-evolving domain.

5.1 Limitations

It is essential to acknowledge certain limitations inherent to the scope and methodology of the study. These limitations impact the comprehensiveness and generalizability of the findings. Despite our rigorous search and selection criteria, there is a possibility of publication bias. Studies reporting negative or inconclusive findings may be less likely to be published, potentially leading to an overrepresentation of positive outcomes related to drone applications in religious management. The available literature predominantly represents drone applications in religious management from specific geographical regions, particularly North America and Europe. This geographical bias may limit the generalizability of findings to a global context, where regulatory and contextual factors may vary significantly. While the field of drone technology is rapidly evolving, the included studies span a range of years, and the technology itself has evolved during this time. Some older studies may not reflect the current capabilities and challenges of drone applications, while newer studies may not have had sufficient time for comprehensive evaluation. Religious institutions are highly diverse in their practices, beliefs, and management structures. The review's findings may not fully encompass the breadth of these differences, and specific applications and challenges may vary widely between religious denominations and organizations. The regulatory environment for drone use can vary widely between countries and regions. This review does not delve deeply into the specific regulatory nuances of each location, and readers are encouraged to consult local regulations when considering drone applications.

The studies included in this review encompass a diverse array of research designs, objectives, and methodologies. This heterogeneity poses challenges in directly comparing and synthesizing findings, as each study's context and focus may differ substantially. While the discussion on ethical considerations in drone applications, this review does not provide an in-depth ethical analysis. Ethical aspects are complex and context-dependent, and further research or specialized reviews may be needed to explore these dimensions comprehensively.

5.2 Future outlook

Given the acknowledged limitations, future research in this domain should diligently work to overcome these constraints. This could be achieved by conducting studies that encompass a broader spectrum of geographical regions and cultural contexts. Such an approach will provide a more comprehensive understanding of global trends and challenges concerning the utilization of drones in religious management planning. Additionally, long-term studies are imperative for tracking the evolution of drone technology and its evolving impact on religious management practices, offering a dynamic and evolving perspective on this rapidly changing field. Moreover, there's a pressing need for an in-depth investigation into the ethical, cultural, and societal dimensions of drone technology within religious institutions. This should specifically address the unique values and concerns of diverse religious communities. Lastly, the establishment of standardized research methodologies and data collection frameworks for assessing the impact and effectiveness of drone applications in religious management will greatly facilitate more meaningful cross-study comparisons.

6. APPENDIX

A.1. Table of literature review categorization

Title	Author	Data Processing Method	Implementation
Predicting residential septic system malfunctions for targeted drone inspections	William Reckling, Jay Levine, Stacy A.C. Nelson, Helena Mitasova	Machine learning	Infrastructure planning
Reconstruction of archaeological contexts through the integrated use of airborne LiDAR and geophysical survey: The case study of San Pietro Infine (Caserta, southern Italy)	Rosa Di Maio, Antonio Emolo, Alessia Frisetti, Nicodemo Abate, Mauro La Manna, Ivano Pierri, Rosanna Salone, Stefania Tarantino	LiDAR	Cultural heritage
The integration of terrestrial laser scanning and terrestrial and unmanned aerial vehicle digital photogrammetry for the documentation of Chinese classical gardens – A case study of Huanxiu Shanzhuang, Suzhou, China	Huilin Liang, Weizheng Li, Siqi Lai, Lingxi Zhu, Wenli Jiang, Qingping Zhang	Photogrammetry	Cultural heritage
New insights into prehispanic urban organization at Tiwanaku (NE Bolivia): Cross combined approach of photogrammetry, magnetic surveys and previous archaeological excavations	M.-A. Vella, E.G. Ernenwein, J.W. Janusek, M. Koons, J. Thiesson, C. Sanchez, R. Guérin, C. Camerlynck	Orthophoto, DEM	Cultural heritage
Multi-source data-based 3D digital preservation of largescale ancient chinese architecture: A case report	Xiang Gao, Hainan Cui, Lingjie Zhu, Tianxin Shi, Shuhan Shen	Photogrammetry	Cultural heritage
Resilient cultural heritage through digital cultural heritage cube: Two cases in South Korea	Yoonjo Choi, Yun-Jung Yang, Hong-Gyoo Sohn	GIS	Data inventory
Collaborative 3D real modeling by multi-view images photogrammetry and laser scanning: The case study of Tangwei Village, China	Yinglong Hu, Xinxiang Chen, Zixin Tang, Jian Yu, Yingbiao Chen, Zhifeng Wu, Dexiao Yang, Yongming Chen	Photogrammetry	Cultural heritage
Inca water channel flow analysis based on 3D models from terrestrial and UAV laser scanning at the Chachabamba archaeological site (Machu Picchu National Archaeological Park, Peru)	Sieczkowska Dominika, Ćmielewski Bartłomiej, Wolski Krzysztof, Paweł B. Dąbek, José M. Bastante, Wilczyńska Izabela	LiDAR	Cultural heritage
Multi-centric, Marsh-based Urbanism at the early	Emily Hammer	Aerial photography	Cultural heritage

Mesopotamian city of Lagash (Tell al-Hiba, Iraq)			
3D LiDAR and multi-technology collaboration for preservation of built heritage in China: A review	Yuan Li, Long Zhao, Yiping Chen, Na Zhang, Hongchao Fan, Zhenxin Zhang	LiDAR	Cultural heritage
Daylighting performance assessment of traditional skywell dwellings: A case study in Fujian, China	Gerui Sui, Jue Liu, Jiawei Leng, Fei Yu	Photogrammetry	Infrastructure planning
SVD-based point cloud 3D stone by stone segmentation for cultural heritage structural analysis – The case of the Apollo Temple at Delphi	Demitrios Galanakis, Emmanuel Maravelakis, Danae Phaedra Pocobelli, Nectarios Vidakis, Markos Petousis, Antonios Konstantaras, Marilena Tsakoumaki	Photogrammetry, Machine learning	Infrastructure planning
Field testing for structural behavior of a stratified monumental complex over time: Palazzo Colonna-Barberini and Templum Fortunae Praeneste	Silvia Santini, Marina Cogotti, Carlo Baggio, Valerio Sabbatini, Claudio Sebastiani	Photogrammetry	Cultural heritage
Preserving our heritage: A photogrammetry-based digital twin framework for monitoring deteriorations of historic structures	Xiangxiong Kong, Ronny Garrett Hucks	Photogrammetry	Cultural heritage
Study on the characterization of differential weathering feature based on surface roughness theory and 3D laser scanning: A case study of the Suoyang Ancient City	Zhiqian Guo, Qiang Qi, Shuai Zhang, Wenwu Chen, Chong Wu, Haiyu Wu	Photogrammetry	Cultural heritage
3D modeling of historical measurement instruments using photogrammetric and laser scanning techniques	Muhammed Enes Atik, Zaide Duran, Mustafa Yanalak, Dursun Zafer Seker, Abdulaziz Ak	Photogrammetry	Cultural heritage
Pilgrimage walk optimization: Folk culture-inspired algorithm for identification of bridge deterioration	Jui-Sheng Chou, Chi-Yun Liu	Machine learning	Infrastructure planning
Integration of reverse engineering and non-linear numerical analysis for the seismic assessment of historical adobe buildings	Rafael Aguilar, María F. Noel, Luis F. Ramos	Photogrammetry	Cultural heritage
Integrated geophysical investigations to reconstruct the archaeological features in the episcopal district of Side (Antalya, Southern Turkey)	İrfan Akca, Çağlayan Balkaya, Andreas Pülz, H. Sabri Alanyalı, Mehmet Ali Kaya	GPR	Cultural heritage

Generating a virtual tour for the preservation of the (in)tangible cultural heritage of Tampines Chinese Temple in Singapore	Osten Bang Ping Mah, Yingwei Yan, Jonathan Song Yi Tan, Yi-Xuan Tan, Geralyn Qi Ying Tay, Da Jian Chiam, Yi-Chen Wang, Kenneth Dean, Chen-Chieh Feng	Photogrammetry	Cultural heritage
Structural assessment and seismic analysis of a 14th century masonry tower	Francesco Micelli, Alessio Cascardi	Photogrammetry	Cultural heritage
On the accuracy of UAV photogrammetric survey for the evaluation of historic masonry structural damages	Nicola Cavalagli, Massimiliano Gioffrè, Silvia Grassi, Vittorio Gusella, Chiara Pepi, Gian Marco Volpi	Photogrammetry	Cultural heritage
Implementation of ultra-light UAV systems for cultural heritage documentation	Tolga Bakirman, Bulent Bayram, Burak Akpinar, M. Fahri Karabulut, Onur Can Bayrak, Alper Yigitoglu, Dursun Zafer Seker	Photogrammetry	Cultural heritage
Distant augmented reality: Bringing a new dimension to user experience using drones	Distant augmented reality: Bringing a new dimension to user experience using drones	Machine learning	Cultural heritage
Mapping Ancient Battlefields in a multi-scalar approach combining Drone Imagery and Geophysical Surveys: The Roman siege of the oppidum of Cabezo de Alcalá (Azaila, Spain)	Paula Uribe, Jorge Angás, Francisco Romeo, Fernando Pérez-Cabello, Diego Santamaría	LiDAR	Cultural heritage
Data for 3D reconstruction and point cloud classification using machine learning in cultural heritage environment	Massimiliano Pepe, Vincenzo Saverio Alfio, Domenica Costantino, Daniele Scaringi	Photogrammetry, Machine learning	Cultural heritage
Integration of NDT, 3D parametric modelling, and nonlinear numerical analysis for the seismic assessment of a vaulted stone-masonry historical building	César Chácara, Rony Reátegui, Álvaro Oré, Percy Suarez, Rafael Aguilar	Photogrammetry	Cultural heritage
Response to Emily Hammer's article: "Multi-centric, Marsh-based urbanism at the early Mesopotamian city of Lagash (Tell al Hiba, Iraq)"	Holly Pittman, Reed Goodman, Sara Pizzimenti, Paul Zimmerman, Jennifer Pournelle, Liviu Giosan	Aerial photography	Cultural heritage
First application of reinforced concrete in Spain and first European application in bridges: The rehabilitation of the Roman bridge of Alcántara	Juan Pedro Cortés-Pérez, Mario Núñez-Fernández, Alfonso Cortés-Pérez, Montaña Jiménez-Espada	Photogrammetry	Cultural heritage
Freely available LiDAR-derived digital terrain model (DTM) uncovers the	Aurora Petan, Alexandru Hegyi	LiDAR	Cultural heritage

heartland of the dacian kingdom			
Combined use of ultrasonic pulse velocity (UPV) testing and digital technologies: A model for long-term condition monitoring memorials in historic Grove Street Cemetery, New Haven	Kiraz Goze Akoglu, Eleni Kotoula, Stefan Simon	Photogrammetry	Cultural heritage
Archaeological surveying with airborne LiDAR and UAV photogrammetry: A comparative analysis at Cahokia Mounds	Justin M. Vilbig, Vasit Sagan, Christopher Bodine	LiDAR	Data inventory

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