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3D SCHOLARLY EDITIONS FOR BYZANTINE STUDIES: MULTIMEDIA VISUAL REPRESENTATIONS FOR HISTORY, ART HISTORY AND ARCHITECTURAL HISTORY

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ABSTRACT:

The Byzantine Empire has bequeathed to us a rich legacy of Christian churches, many of which possess historical and cultural significance. Unfortunately, the majority of these structures are currently undergoing a process of decay, having not received adequate preservation efforts. Moreover, the absence of collaboration between researchers in the various fields, each with their own focus on the study of Byzantine churches, presents a pressing need for dialogue and a collective response from these researchers. The region of Laconia, located in the south of Greece, is particularly in need of immediate attention, given the abundance of churches located therein. To address these challenges, the authors propose a novel approach involving the documentation of these churches in a digital format through the presentation of 3D models as scholarly editions that incorporate all available data sets in a multimedia format. This paper delineates several requisite specifications for 3D scholarly editions, which hold the key to solving the twin problems faced by Byzantine churches, namely, their protection and the scarcity of interdisciplinary collaboration amongst researchers. With 3D scholarly editions based on multimedia resources and adequate information management, it will be possible to facilitate collaboration and research between various fields of Byzantine studies, and beyond. Such efforts will serve to ensure that cultural heritage passed down from previous generations will be transmitted to future ones.

1. INTRODUCTION

Throughout the history of the Byzantine Empire (roughly the 4th to the 15th century), a significant number of Christian churches were constructed, each with their own founders, dedicators, purposes, sizes, and styles. These churches served as a vital infrastructure for social life during the period. These monuments are important not only as valuable historical heritage sites that provide insights into Byzantine society but also due to their lasting influence on the architecture of Eastern Europe and the Middle East over time (Ousterhout, 2019, pp. 679-713). Thousands of these churches remain in the former imperial territories, and some of them continue to be used in present-day communities. However, a minimal number of them have been adequately preserved, while many are undergoing a process of deterioration.

Byzantine churches have traditionally been studied in isolation by different disciplines, including history, art history, architectural history, and archaeology. Each discipline tends to focus on specific aspects of a church, such as its buildings, mural paintings, and inscriptions, leading to limited comprehensive research on the role these elements played in the overall buildings. Consequently, studies on Byzantine churches encounter two significant problems: the inadequate protection of monuments and the scarcity of interdisciplinary collaboration among researchers. Urgent discussions are necessary, with the participation of researchers from various fields, to address these challenges.

In this regard, the region of Laconia in Greece is a prime example of an area that necessitates immediate action (**Figure 1**). Located in the southern Peloponnese and bordered by two mountain ranges, this region has a rich and complex history, marked by numerous conflicts and changes of rulers spanning several millennia. As Christianity gradually spread but in a complex manner throughout the region from the 4th century onwards, hundreds of churches were constructed. According to Drandakis (1996), at least 200 churches with paintings are still in existence in Laconia, a number that rises when including those without paintings (cf. Nagatsuka, 1994; Bender, 2019; Bender 2022). Most of the remaining churches date from the 13th century onwards, with many built after the Byzantine reconquest of Laconia from the Franks in the second half of that century.

Figure 1. Location of Laconia.

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Notably, the churches in Mystras, the capital of the Despotate of Morea, a province which flourished in the later Byzantine Empire, are among the most significant examples in Laconia. Due to their exceptional historical and ecclesiastical importance, they were inscribed on the World Heritage List in 1989.

Given the challenge of implementing sufficient conservation measures for all the hundreds of churches, our approach is to document these monuments in digital formats, ranging from inscriptions to the buildings themselves. Our proposed method for heritage conservation involves creating 3D scholarly editions that integrate available data sets in a multimedia format. This paper examines the specifications necessary for producing 3D scholarly editions that can help solve the two primary challenges that Byzantine churches face. Our discussion is grounded in our fieldwork conducted in Laconia, where we conducted research in February 2023, August 2022, and a pilot survey in March 2019, with the permission of the Ephorate of Antiquities of Laconia.

2. WHAT IS A 3D SCHOLARLY EDITION?

Recent advances in information technology have made 3D measurement more accessible. Light detection and ranging (LiDAR) devices and photogrammetry software have become increasingly popular for surveying archaeological sites and documenting cultural heritage, such as architecture (e.g. Vitale, 2018; Balletti et al., 2021; Guerriero et al., 2022).

As Yang et al. (2020) pointed out, such heritage documentation can be combined with 3D modelling and information management, especially since the 2010s, with the development of the building information modelling (BIM) technique in historic/heritage building information modelling (HBIM). At the same time, applying such 3D models to humanities research requires what are known as scholarly editing practices. Scholarly editing originally emerged to ensure that a text is academically credible, but in the context of recent digital scholarly editions, it is no longer limited to written texts (Sahle, 2016). For example, the integration of 3D models and scholarly-edited text was reported by Leoni et al. (2015). Schreibman and Papadopoulos (2019) explained the need for 3D models used to recreate past events to have a certain reliability, much like a digital scholarly edition of texts.

Although Schreibman and Papadopoulos (2019) focused their discussion on the (re)construction of 3D models, these concepts should be applicable to heritage documentation, especially for fields within the humanities that focus on the past, including Byzantine studies.

For old churches, it is crucial to record not only their current state but also any alterations that have been made. In Byzantine studies, the part of a church before 1453 (the year when Constantinople, the capital of the Byzantine Empire, fell to the Ottomans) is of utmost importance. However, churches often undergo changes in subsequent periods, such as repainting and renovation, making it necessary to carefully observe and identify which parts of a church originated in a particular period.

Only a small number of Byzantine churches are fortunate enough to have a precise date of foundation, and most lack specific clues, such as dedicatory inscriptions, for dating. Therefore, the foundation date of a church often has to be inferred based on the style of wall paintings and/or architectural form. Even when inscriptions have survived, they are often damaged and written in abbreviated and vernacular mediaeval Greek, so it is necessary to interpret and edit them by a specialist. To use the results of heritage documentation as a source for humanities research, particularly in Byzantine studies, it is necessary to unify 3D models, 2D images, and textual data of these churches, accompanied by scholarly annotations for each element. In recent times, protecting and passing on cultural heritage has become more diverse with multidisciplinary and international initiatives. One example is ARCHES (At-risk Cultural Heritage Education Series), funded by the National Endowment for the Humanities and hosted by *smarthistory*, a public art history centre with thousands of free videos and essays by experts willing to share their knowledge with learners worldwide. Because of the strong belief that an informed public is essential to ongoing efforts to protect cultural heritage, ARCHES offers a mini-course on endangered heritage around the world (Harris and Zucker, 2017). Open Heritages 3D (https://openheritage3d.org/about), hosted by the Cultural Heritage Engineering Initiative at the Qualcomm Institute at the University of California San Diego, is a collaborative project between CyArk, the University of California San Diego, Historic Environment Scotland, and the University of South Florida Libraries. It provides free access to high-resolution 3D datasets of cultural heritage sites around the world. In contrast to these cases, our 3D scholarly editions, which will unite 3D models, 2D images, and textual data with scholarly annotations, will form a comprehensive database of Byzantine churches in Laconia. It will be highly accessible, particularly to scholars studying the region, with multimedia resources providing visual representations.

3. 3D SCHOLARLY EDITIONS FOR BYZANTINE CHURCH STUDIES

This section discusses the requirements for 3D editions in Byzantine church studies, using the church of Agios Iōannēs Chrysostomos (St. John Chrysostom) in Geraki, Laconia, as a case study (**Figure 2**). This small church, measuring 4.7 m × 11 m, is valuable because of an inscription that mentions the explicit date of 1450 and of the good condition of wall paintings that covers almost the entire interior. The inscription is not from the period of original construction but was installed later, and the building and murals are estimated to date from an earlier time. According to Moutsopoulos and Dimitrokallis (1981, pp. 44-45), the foundation of the church was approximately 1300, and this assumption is widely accepted (Gerstel, 2001, p. 278; Papalexandrou, 2013, p. 43), although it has been debated (Zias, 1976-78, pp. 331-333). The church was abandoned at some point during the Ottoman occupation and was in a state of disrepair in the early 20th century (Adamantiou, 1908, p. 23). However, since the 1930s, the roof, the pavement, and most of the murals have been restored intermittently, and it is now in reasonably good condition. One of the church's architectural features is the extensive use of spolia, or reused building materials, from the ancient Greek and Roman periods. In addition to the stonework inscribed with Emperor Diocletian's price edict on the doorframe of the entrance to the south, a remarkable amount of spolia is found on the south façade (**Figure 3**).

During the field survey, we discussed the focus of each discipline and what kind of information should be integrated into the 3D edition of a church. For example, historians are primarily concerned with the reproducibility of written texts, while architectural historians are concerned with the documentation of metric data and the precise form of a building. Below are some of the specific areas of focus for each discipline.

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Figure 2. Exterior of Ag. Iōannēs Chrysostomos Church, from the northeast side.

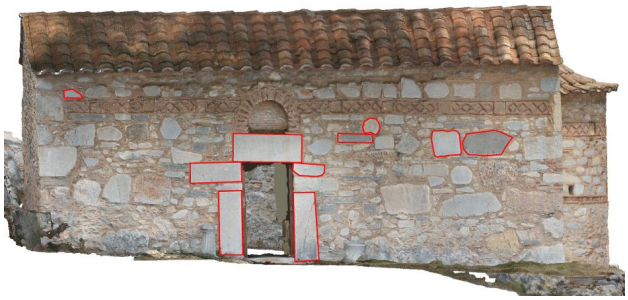

Figure 3. South facade of Agi Iōannēs Chrysostomos Church (recognised Spolia are highlighted with red lines by the authors)

Figure 4. Portrait of Christophoros Kontoleos.

In terms of textual content, this church has numerous epigrams and explanative captions that accompany the wall paintings. For example, the dated inscription mentioned earlier is located next to a portrait (**Figure 4).** The text is mostly legible, written in medieval Greek, but it omits certain letters according to the conventions of the time and requires specialist knowledge to be understood. The Greek text and an English translation are as follows (Feissel and Philippidis-Braat, 1985, pp. 356-357).

Text: +Ἐκοιμήθ(η) ὁ δοῦ[λος τοῦ]/ Θ[εο]ῦ Χριστοφόρος ἱερ[εὺς]/κ(αὶ) χαρτοφύλαξ [ὁ]/ Κοντολέως ἐν [μη-]/ νὶ Ἰανουαρίῳ [1-2]/ τοῦ ,ϛϡνη΄ ἔ(τους) [(1)]

English translation: The servant of God, Christophoros Kontoleos, cleric and chartophylax, was laid to rest on … January in the year 6958 (i.e., 1450 AD).

Historians have emphasized the importance of the content of this text in church studies, but they have not paid attention to the visual effects of the inscription, such as its placement and its relationship with the portrait, in its context within the church. By integrating the transcription of this inscription into the 3D scholarly edition and presenting it in a way that is close to reality, it is expected that research progress can be made from this perspective.

Most murals have short captions that explain the scene and person depicted, but these texts are often overlooked and sometimes not transcribed in research literature. However, these short texts are important for interpreting the role of the mural paintings and for understanding the characteristics of the language at the time. Therefore, appropriate transcription and editing should be done. As an example, **Figure 5** shows an image of the Presentation of Mary, painted on the upper south wall of the church. The following caption, located in the upper left, plays a role in explaining the scene to the viewer: “Τά εἰσόδια τῆς ὑπεραγίας/ Θ(εοτό)κου”[(2)] (The Presentation of Most Holy Mother of God).

In terms of 3D scholarly editions, it will be necessary to present the murals themselves as high-resolution images and include 3D information such as mural locations in the building. As murals in poor condition are not uncommon in Byzantine churches, one role of a 3D scholarly edition may be to propose a restoration plan for them. That is, as Barreiro Díaz et al. (2022) pointed out, virtual restoration of the wall paintings and their annotation would also need to be incorporated into any 3D scholarly edition of Byzantine structures.

[(1)] Parentheses indicate abbreviations; letters in square brackets are restitutions by Feissel and Philippidis-Braat (1985); slashes indicate line breaks.

[(2)] Transcribed by the authors; revising that in Moutsopoulps and Dimitrokallis, 1981, p. 38; Parentheses indicate abbreviations; slashes indicate line breaks.

Figure 5. Scene of presentation of St Mary with text.

Many Byzantine churches, including the one under study, suffer from insufficient natural light due to a lack of windows, making it difficult to see murals clearly with the naked eye. As for research resources, high-quality photographs taken under optimal lighting conditions and, at times, enhanced through image processing, must be integrated into a 3D scholarly edition. Moreover, it may be necessary to document metadata on the motifs of the murals and the individuals and objects portrayed in each scene.

Architectural history involves studying history through architecture. Many historical buildings were built manually, resulting in distortions and irregularities in their walls and ceilings. Karydis (2011) suggests that the distortion of vaults and arches in Byzantine architecture was caused by the location of the centring during construction. Therefore, information on warping is essential for understanding the construction activities of the time. Traditional 2D drawings may overlook such distortions, whereas 3D measurements provide an as-built record of the monument. Despite being crucial resources for architectural history studies, the drawings omit key details. **Figure 6** is an example and comparison of drawings of the church of Agios Iōannēs Chrysostomos (Moutsopoulos and Dimitrokalis, 1981) with the 3D model from our survey. The vaults in the drawings appear as neat semicircles, whereas in reality, they are more squashed. In the absence of written sources that directly show the activities of craftsmen at the time, 3D scholarly editions can also serve as an essential tool for understanding the construction methods used for arches and vaults. In addition, continuous 3D measurements of the building can help track any deformations over time. This information will allow structural reinforcement, conservation, and restoration work to be carried out at the appropriate time.

Figure 6. Comparison of drawing and 3D modelling (left: Moutsopoulos and Dimitrokallis, 1981; right: 3D modelling processed by the authors).

Furthermore, although Byzantine churches were dimly lit, they were by no means neglectful of light. They created sacred spaces that effectively utilized both natural and artificial light to enhance their spiritual atmosphere (Potamias, 2017). However, there are various difficulties in reproducing such light spaces in physical churches. Nevertheless, by incorporating metric data and information on the surrounding environment, 3D scholarly editions can simulate lighting and sound environments that are difficult to recreate in real-life settings. This is only achievable in a virtual space.

Thus, 3D modelling provides accurate and precise information about building forms. It allows architectural historians to understand the construction process without historical sources and to understand how buildings deteriorate over time. 3D scholarly editions can show such information or analysis by architectural historians, which was difficult to understand without an architectural background.

Figure 7 shows a conceptual diagram of a 3D scholarly edition. In the following section, we discuss how 3D scholarly editions can serve as a platform in the fields of history, art history and architectural history.

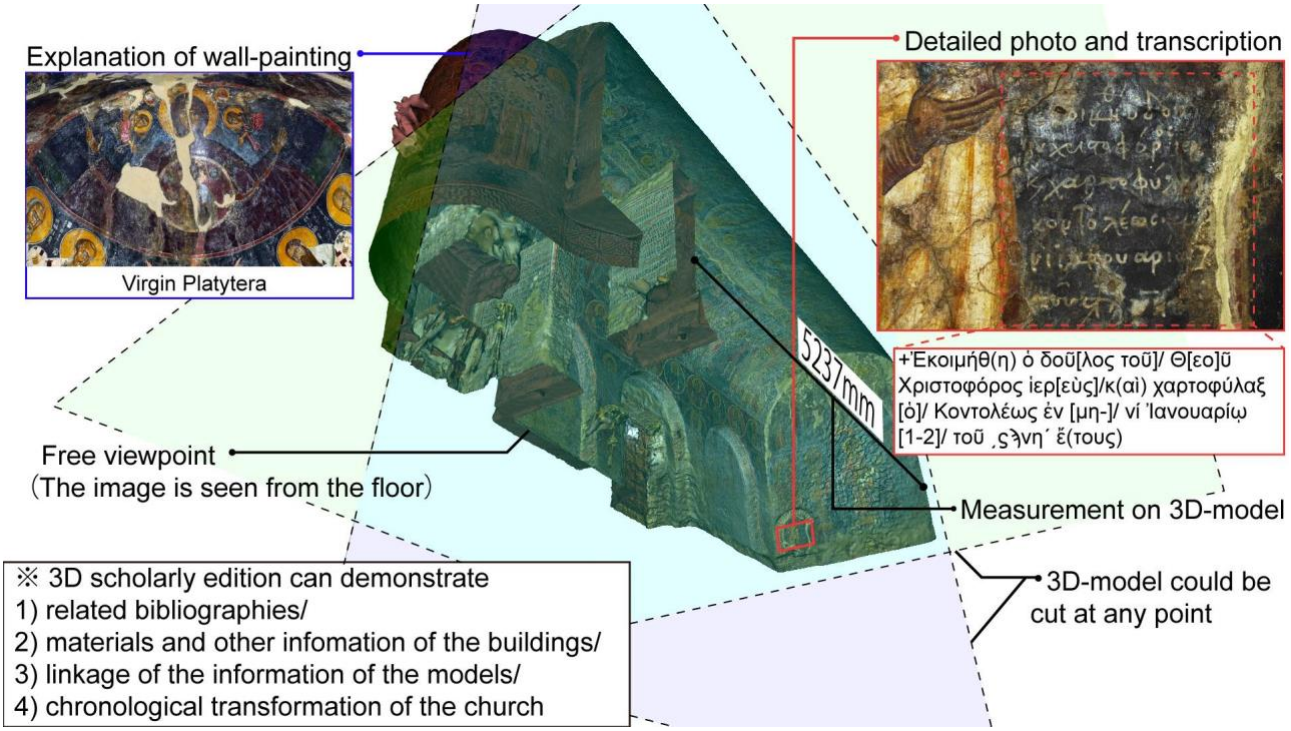

Figure 7. Conceptual diagram of a 3D scholarly edition.

4. PROGRESS OF THE PROJECT AND WHAT A 3D SCHOLARLY EDITION BRINGS

There are more than 200 Byzantine churches with murals in the region of Laconia, as Drandakis (1996) points out. However, previous studies have either been geographically limited, such as the investigation of the Mani peninsula by Drandakis (1995), or focused on rock-hewn churches, as in Bender’s recent work (2022). A comprehensive survey of all the churches in the area is necessary for academic purposes.

To address this gap, we, together with Dr P. Perdikoulias, Dr K. Takeda, Dr F. Condorelli and Ms E. Ota, initiated a full-scale survey in 2022, based on the pilot survey in 2019. Currently, we have finished taking photographs for photogrammetry of the 22 churches and are working on their 3D modelling and organization of the various information needed for 3D scholarly editions. These editions aim primarily to assist researchers, while also promoting new collaborations. Therefore, 3D scholarly editions may only serve as a part of data preservation, rather than an immediate and significant benefit in real restoration work. However, it is also true that there is a lack of resources for conserving and restoring churches throughout the Laconian region. This kind of documentation work can in itself compensate for the situation.

The 3D scholarly editions could themselves become museum content if a future collaboration with the local Ephorate can be established. If made available to the general public, they could increase momentum for protecting the churches themselves among the local population and beyond. Protecting cultural heritage, as Harris and Zucker (2017) point out, requires the consent of many. The Smithsonian Voyager Story could be an effective tool for providing multimedia annotations of 3D scholarly editions to a wider audience, as suggested by the PURE 3D group (https://pure3d.eu/).

A 3D scholarly edition of a Byzantine church encompasses a wealth of information equivalent to or even surpassing that of the physical church. This means that 3D scholarly editions enable researchers to conduct investigations without physically visiting the churches. Numerous Byzantine churches are constantly threatened by decay and harm, leading to the loss of invaluable information at an alarming pace.

In many instances, wall paintings, inscriptions, or the structures themselves, which were documented during their prime, have either vanished or are no longer visible. In addition to the loss of cultural heritage due to natural and human-made disasters, access to churches can be restricted at any time and for any reason, as demonstrated by the COVID-19 pandemic since 2020. Given that the state of many churches continues to deteriorate, it is essential to develop and transfer digital editions of these structures that meet scholarly requirements, with the goal of preserving cultural heritage for future generations.

3D scholarly editions provide a valuable means of promoting interdisciplinary research by consolidating information and enabling researchers from various disciplines to collaborate and share insights regarding the features of a church. The complex nature of historical, art-historical, and architectural-historical research necessitates a high level of expertise and knowledge within each field, which often presents a challenge when researchers attempt to interpret information that pertains to other areas of study. However, by creating a platform that presents a wide range of information in a visually appealing manner, 3D scholarly editions foster a deeper understanding of the different disciplines involved and thus encourage researchers to collaborate more closely. We believe that such interdisciplinary, collaborative research is crucial to comprehending the social function of churches in Byzantine society. Additionally, we hope that such research will help clarify various phases of a church’s history, including its founding, renovation, and alteration.

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5. CONCLUSIONS

The above discussion has focused on the churches of the Byzantine Empire, which have had a significant cultural impact on Eastern Europe and the Middle East to the present day, and on the potential significance of 3D scholarly editions of these churches. Despite their being an essential social infrastructure and although a significant number are still in use today, many churches have not been adequately preserved and are in danger of deterioration and extinction. Of course, it would be most desirable to conserve and restore churches in the real world, but it is difficult to do so due to budget and human resource constraints. In this context, we propose a 3D scholarly edition in which 3D modelling is created through 3D measurement, which has become possible with developments in information technology.

In Byzantine studies, history, art history and architectural history each focus on a different aspect of a building, so the information required differs. A 3D scholarly edition, which has been edited after collecting all such information, removes a significant barrier to Byzantine studies – distance – and makes it possible to study churches without visiting them. At the same time, the visual presentation of diverse information on a single platform encourages individual researchers to understand and collaborate with those in other disciplines and to contextualise the elements they are focused on in a broader context, such as the relationship between text, image, and space. Finally, a 3D scholarly edition, edited to the best of humanity’s current knowledge, is a digital twin of a church in danger of disappearing, documented in as much detail as possible in the virtual world. It is a small step towards passing on the cultural heritage inherited from previous generations to the next.

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The rights to the images of Figure 2–7 belong to the Ministry of Culture and Sports. The Church of Agios Iōannēs Chrysostomos in Geraki is within the domain of the Ephorate of Antiquities of Laconica, Hellenic Ministry of Culture and Sports/ Hellenic Organization of Cultural Resources Development.

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