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Historical-graphical analysis and digital preservation of cultural heritage: case study of the baptismal font of the church of Santiago Apóstol in Montilla (Córdoba, Spain)

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Abstract

Stone is a characteristic element in the construction of buildings and monuments in the Middle Ages in Spain. This is so mainly due to its durability and, in baptismal fonts, specifically, its symbolism: Jesus Christ is the cornerstone, he comes to save us and is the foundation of the life of the Christian and of the Universal Church. The application of virtual 3D reconstruction is essential in the conservation of this type of heritage, together with scientific techniques and methods, and the analysis of historical-graphic documentation. Focusing on these three aspects, the baptismal font of the church of Santiago Apóstol de Montilla will be taken as a reference. The baptismal font of the church of Santiago Apóstol in Montilla (Córdoba, Spain), whose exact origin is unknown, is one of the most important heritage assets. San Francisco Solano, known as the "Thaumaturge of the New World", was baptised in it. For over four centuries, the temple has been the Main Church of the head of the Marquisate of Priego. This study aims to know, document and carry out a digital reconstruction of an important piece of the monumental heritage of the Catholic Church: the baptismal font of the church of Santiago Apóstol in Montilla. To this end, we searched a major literature review focused on the use of photogrammetry for reading old graphics and deciphering texts. After that we analysed the graphic documentation derived from the restoration process conducted by Cordovan restorer Vázquez Arjona in the late twentieth century. The application of 3D digitisation and documentation techniques has allowed not only to analyse this important heritage element in detail through a virtual reconstruction, but also to make a far-reaching discovery regarding one of its elements, the unknown inserted inscription in the baptismal font band.

Keywords: Cultural heritage, Baptismal font, Restoration, Stone materials, 3D model, Photogrammetry, Deciphering old graphics and texts

Introduction

Stone materials, due to their durability and resistance, have been used since ancient times to manufacture multiple architectural and monumental elements. The use of stone in Spain is widespread due to the geological characteristics of the territory.

The baptismal font is one of the main elements in the administration of the initiation sacrament through which Christians are incorporated to the Church [1]. Its location in the temple has always been rich in symbology. Thus, in the Middle Ages, there were fonts at the side of the gospel, which symbolised the abandonment of sin. Fonts were also placed at the bottom of the nave of the epistle; this was referenced as the darkness, implying

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that the person who was being baptised came to it to be cleansed of the sin to come out of the darkness in which his/her soul was [2–4]. This symbolised that the person who was being baptised came with the sin, in order to be cleansed from it through the grace of the sacrament [5]. Baptismal chapels were also usually closed with gates. The one studied within this research is of great relevance, not only iconographically, but also because San Francisco Solano received the baptismal waters in it [6].

The application of digitalisation and 3D documenting techniques in the preservation of heritage are of great relevance nowadays, as they provide architects, archaeologists, and restorers with innovative resources for its restoration. They are also among the main tools to improve their knowledge and dissemination [7–16]. These techniques have been used to reproduce cities or monuments that have disappeared. As it can be seen in the reconstruction of Gothenburg in the sixteenth century, carried out on the occasion of the fourth centenary of its foundation [7]. Showing itself as an example of the confluence of science and cultural heritage through virtual heritage. These techniques have also served to approach such emblematic and changing monuments over the centuries as Cenacle of Jerusalem [10], getting to know each of its transformations through the documentation of building, as stated by Hermon.

These techniques are of great interest for being non-invasive or non-destructive tools for cultural heritage research. Despite their great relevance, and the suitable characteristics they present, there is little scientific literature regarding the application of them in the decryption of texts and their impact on the field of cultural heritage. For example, Valdés Gallego [17] simply applying photographic retouching techniques on late medieval texts was able not only to decipher a list of existent relics in the main altar of the church of San Salvador de Valdediós (Asturias, Spain), made in some paintings on stone, but even dating the inscription itself. Likewise, the work of Melard [18] is developed on paintings on stone walls, specifically those of the Chateau de Selles de Cambrai, one of the most important French medieval monuments. Their results have subsequently been used by archaeologists and palaeographers to study and decipher them precisely. This way, 3D models were generated by photogrammetry techniques implementation. Alternative methods such as the one of Reflectance Transformation Imaging are interesting to reading text in rough objects having low contrast. Photogrammetry can help decipher some texts when state of conservation is somehow deteriorated.

Concerning inscriptions on stone materials, the work of Papadaki [19], which presents some common points with this research is noteworthy. The accurate 3D model of the inscription in stone material was developed, storing and saving digital data in order to build a digital heritage that serves as a basis for future research work. A structured Light scanner was utilized (SL2 by RGBXYZ Inc.) consisting of two machine vision cameras (5MP) and a standard DLP projector. Lighting problems were found in some rooms [19], because the amount of luminous flux was not optimal within indoor lighting [20, 21].

The photogrammetry tool is being used by architects, archaeologists and restorers, as said before, in processes of restoration and recovery of historical-cultural heritage, but it is true that up to now, no scientific literature has been found to unravel the text of a liturgical piece as important as the baptismal font this study. Likewise, it is important to highlight that this discovery had gone totally unnoticed during the restoration process previously undertaken.

This is a way to highlight how science undoubtedly contributes to the conservation and enhancement of cultural and architectural heritage. Especially in the field of local heritage, when the economic and material resources to achieve its conservation are scarce. In this way, these insights in the cultural heritage knowledge will likely entail a positive economic repercussion in its environment [7, 10, 12, 18]. Through the application of different techniques and methodologies in this sense, it is possible to give visibility to this heritage. This is the way to value and promote it and achieve a greater tourist impact in certain areas of high interest, but unknown.

Research aim

The aim of this research was to document and historiographically study the cultural heritage documentation of rural areas, by the application of a 3D reconstruction methodology in heritage elements in a case study, demonstrating its usefulness in the enhancement and conservation of cultural heritage. The application of this methodology was specified in the baptismal font of the church of Santiago Apóstol in Montilla (Spain), being able to be extrapolated to any other. The present study had multiple objectives: (1) to determine the restoration process of the baptismal font of the church of Santiago Apóstol in Montilla carried out by Cordovan restorer Miguel Vázquez Arjona in 1993; (2) to analyse its iconographic decoration and significance, delving into the study of Calvo Serrano [22]; and (3) to digitally document the font through photogrammetric techniques.

Historical background

The origin of the church of Santiago Apóstol in Montilla is uncertain. Some authors such as Jurado and Aguilar [23] and Lorenzo Muñoz [24] attribute it to the time when the territory was conquered by the troops

of Fernando III the Saint circa 1240, whereas Nieto Cumplido [25] documented its first references in 1437. In the sixteenth century, it was subjected to one of its great modifications. It is worth mentioning that, in 1577, Hernán Ruiz was hired to rebuild the tower of the church. The baptistery was located at the bottom of the tower, and within the baptistery there was the baptismal font [26], as can be observed in Fig. 1. Almost two centuries later, the 1755 Lisbon earthquake caused serious damage to the structure of the church; the tower of Hernán Ruiz had to be demolished, and the current one was built by Montillian master builder Pedro Vela in the eighteenth century [27].

In 1916, the parish priest told the parishioners that the Baptistery could be moved to the bottom of the nave, which was a wider space. In this way, a large chapel could be built, with a beautiful dome in which the image of San Francisco Solano, the patron saint of Montilla, could be placed [29]. In 1941, the parish priest requested authorisation from the Bishopric of Córdoba to build a new cover for the font. The dome was made by carver Antonio González Martínez in walnut wood, although with some slight variations in the crowning over the original sketch (Fig. 2) [30].

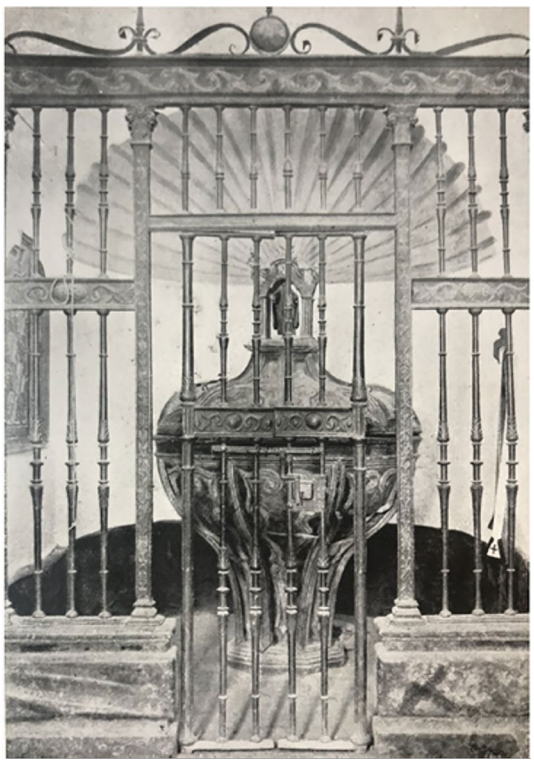

Fig. 1 Baptismal Font of the Parish of Santiago in the primitive Baptismal Chapel in 1911 [28]

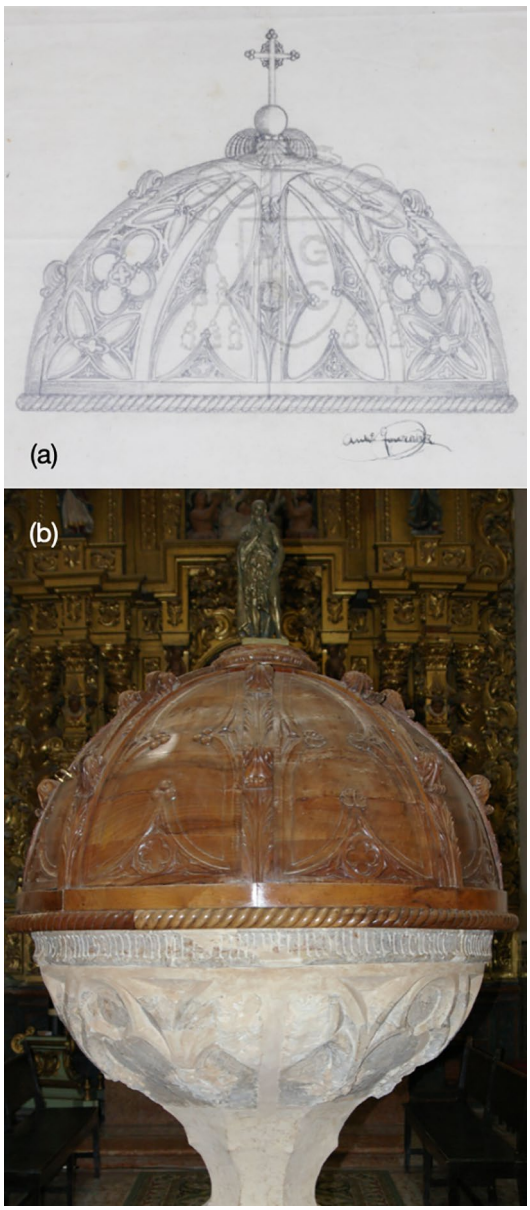

Fig. 2 **a** Sketch of the design of the dome for the baptismal font of the parish of Santiago Apóstol at Montilla by Antonio González [30]. **b** Detail of the cover made for the baptismal font [22]

In addition, to its artistic relevance, the value of this baptismal font lies in the fact that San Francisco Solano received the baptismal waters there. Likewise, the church that houses it, and probably the font itself, were built after the Reconquest, under the auspices of the Lords of Aguilar, ancestors of Gonzalo Fernández de Córdoba, the Great Captain, a key figure in the History of Spain.

Materials and methods

The restoration of the monumental heritage is fundamental for its conservation and restoration of its value. The Restauro Letters of 1972 [31] parameterised the methodology to be followed for the intervention in sculpture and stone monuments. They established a series of factors to be considered: the history of the monument, the materials, the formal description of the element and different indicators of alteration (climatology, orientation, the human factor, pollution, biological agents, etc.).

The methodological foundation for the development of this study is the Restauro Letters. Firstly, a thorough documentary search was conducted in different archives (Archive of the Parish of Santiago Apóstol and the Manuel Ruiz Luque Library Foundation, both in Montilla, the General Archives of the Bishopric of Córdoba and the Central Archive of the Board of Culture and Historical Heritage of the Government of Andalusia), and we also delved into the study of Calvo Serrano [32].

The application of digitalisation and 3D documenting techniques provides important information for the restoration, conservation and recovery of cultural heritage. They are also among the main tools to improve their knowledge and dissemination [7, 33]. In the case of the baptismal font of the church of Santiago Apóstol in Montilla, photogrammetric techniques based on Structured from Motion were used to digitally document the piece due to its size. These tools allowed conducting a virtual reconstruction of the font, for its preservation and documentary record. These techniques use 2D graphic information (photographic images) captured in situ from different angles, to then create the final 3D digital object [34–36]. The software used to carry out the photogrammetry in this project was Agisoft Metashape v.1.7, which, through the capture of multiple images, allows estimating the position of the camera from which the 2D images were taken and calculating the position of the projection centres in space, creating the necessary Point Cloud to form the 3D object. We decided to work with Metashape due to the stability and precision it provides in difficult environment and big surveys [37] and the studies carried out on different columns and inscriptions of the Mosque-Cathedral of Córdoba with different parameters and variables [38].

A NIKON D5300 camera was used, which has a resolution of 6000×4000 pixels and a CMOS sensor of 23.5×15.6 mm, with a lens Nikon DX AF-P Nikkor 18.55 mm 1:3.5–5.6G VR. The computer used for the photogrammetric survey is an Intel Core i7-9700 3.00Ghz processor, 32 Gb RAM memory and NVIDIA GTX 1650 graphic card.

During the capture of the photographs, as it is shown in Fig. 3, the followed pattern guaranteed the correct digitalisation of all the points of the font, respecting an overlapping of 70%. For this process, a tripod was used, taking the photographs at a distance of 0.5–1 m from the font with these parameters we obtain a focused area between 150 and 200 mm. Once the photographs have been taken, their space position and a dense Point Cloud are calculated. With this, we have a 3D Point Cloud scan of the model. From the Point Cloud, the triangular mesh is generated, and the texture, to give a more photorealistic appearance [39], which is calculated from the initial photographs [37]. The photogrammetric calculation time has been 7 h in total.

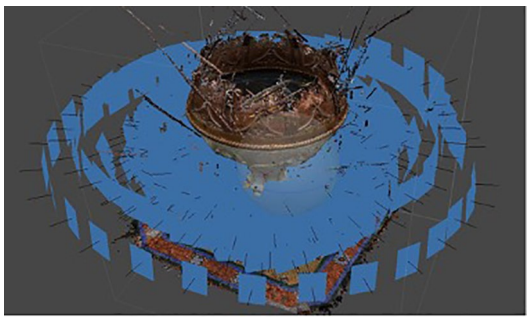

Fig. 3 Photogrammetric process showing the dense Point Cloud and the spatial orientation of the images

The artificial lighting of the church was used to take the images, although, due to the location of the font and its overhead light, it was necessary to use LED spotlights to capture images of the lower areas. We used an adjustable torch 204 LED (175×125 mm) with colour temperature 3200–5600 K. The temperature was adjusted to 4000 K, a neutral white, to match the colour temperature of the existing lamps in that area of the Church to avoid changes in the colour in different photographs. In addition, this torch prevents the excessive emission of heat, ultraviolet and infrared radiation.

The parameters used in the photogrammetric process are gathered in Tables 1 and 2: the parameters of the data collection in Table 1 and those used in the software to obtain the photogrammetric 3D model in Table 2.

Table 1 shows the number of processes around the font. In this case we take photographs in 5 stages with different ISOs, shutter speed and lens aperture, following a similar methodology to other studies carried out [40, 41]. In this way we have obtained the same image with different lighting to be able to work with it in the photogrammetric software. Each of the stages was carried out rotating around the font, varying the parameters except for the Focal length. It is important for this methodology not to modify the distortion of the lens.

Table 1 Parameters and position of the camera for the capture of photographs

Process	Horizontal Angle°	N° of photos	Shutter Speed (s)	Lens aperture	Focal length (mm)	ISO
1	15	120	1/60	f/3.8	24	600
2	15	119	1/30	f/4.5	24	400
3	15	122	1/2	f/8	24	720
4	15	123	1	f/13	24	250
5	15	119	2	f/18	24	400

Table 2 Parameters applied in metashape for the realization of the photogrammetric project

Align photo		Dense cloud		Mesh		Texture	
Accuracy	High	Quality	High	Surface type	Arbitrary 3D	Mapping mode	Generic
Key point	40,000	Depth filtering	Mild	Source data	Dense Cloud	Blending mode	Average
Tie point limit	4000			Face count	High	Texture size	16,384 × 1
				Interpolation	Enabled		
Time (min)	126	Time (min)	242	Time (min)	134	Time (min)	212

For each of the 5 stages, 5 rotations around the baptismal font have been made at different levels, taking photographs at a horizontal angle of 15°. This gives us a total of 24 photos for each turn and level, and a theorical overlap ratio of 0.917, making a total of 120 photos per stage [41]. For the vertical angle in each of the level and turn the camera was kept parallel to the font surface.

Table 2 shows the parameters used in Metashape for the different calculation stages. First, high precision was used for image alignments. Metashape used the original size photos with this option, if we used medium or low, the software downscales by a factor of 4 each time. So low accuracy downscales photos by 16. With key and tie point we limit the number of points per photo used during the align stage. In this way we obtain a good alignment but with a limited amount of time. In total, 126 min for alignment photo stage have been obtained.

In the same way, we use a high-quality dense cloud generation to use the original size photo to obtain a more detailed and accurate geometry. With a mild depth filtering we can obtain the smallest details and maximum precision in order to study the inscription of the font.

Finally, a high face count mesh was calculated to obtain a high-res mesh of all the details and a 16k texture to obtain a photorealistic model.

Once the 3D model is obtained through photogrammetry, we import the generated dense Point Cloud into Cloud Compare software, a open-source software prepared for the work and analysis of Point Clouds (Fig. 4). Using the Unroll tool and knowing the radius of our source (1188 mm diameter), we can obtain the Point Cloud displayed in a single band (Fig. 5).

Fig. 4 Dense Point Cloud imported on Cloud Compare Software

From the Point Cloud we can carry out different height studies to see more clearly the inscription of the font, applying different height filters with the projection rasterize tools from Cloud Compare (Fig. 6).

Results and discussion

Formal description of the baptismal font

This is the first time this baptismal font, relevant for the Spanish cultural heritage, is described and analyed in detail the scientific literature. This is a baptismal font (unknown artist) carved in a single block of limestone, from the Renaissance. It is 1180 mm in diameter and 1145 mm in height, and it is supported on an octagonal base, which holds its crown [42].

Thanks to the technical report made by Luis Montealegre, professor in the University of Cordoba and member to the research group for the Study of the Alteration of the Monuments of Córdoba, we know the

Fig. 5 Unroll Point Cloud

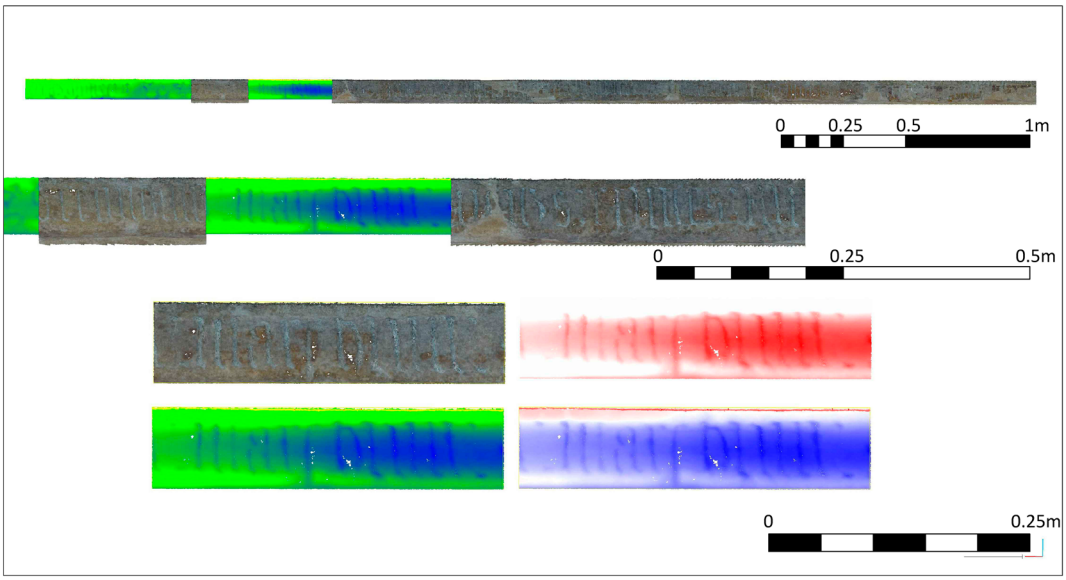

Fig. 6 Height studies and filters applied to study the font

composition of the baptismal font in the church of Santiago Apóstol [34]. It is made of fossiliferous calcareous sandstone from the Oligocene epoch, probably biocalcarenite. It is bright yellow, of fine homogeneous grain, and it is composed of 80% calcite and 15% quartz, with a porosity of 7–9% and an inner permeability of 7%. The studies conducted to date conclude that this stone was probably extracted from detrital-carbonate levels of the Neogene at the olistostromic area around Montilla (Santa Cruz, Castro del Río or Espejo), although the exact origin of the primitive block is difficult to identify [43]. Acedo Gómez erroneously identified marble as a material of this piece [42]. This assertion is not supported by any scientific study. The most complete study in this regard is the one carried out by the University of Córdoba in 1994, to which we refer.

The lower part of the font is decorated with trilobed semicircular arches, with junctions and decorations

made of plant elements related to vineyards and fig trees. The vineyard symbolises Eternal Life; its fruit, i.e., wine, is the blood of Christ in the Sacrifice at the Altar, which thus symbolises the rebirth of the neophyte to Life after receiving the baptismal water. These elements could also be fig tree leaves, since these iconographic elements are part of the emblem of House Feria, of the Figueroa lineage [44]. It was connected to House Priego in 1518, through the marriage between Lorenzo Suárez of Figueroa, III Count of Feria, and Catalina Fernández de Córdoba, II Marquise of Priego [45].

The photogrammetric techniques allowed creating a 3D model of the font (.OBJ) and its textures (.JPG), as is shown in Fig. 7. Table 3 shows the results obtained in Metashape. As can be seen in Table 3, the number of photographs used is 603 and the area documented is equal to 2.98×10^6 mm^2. This gives us that each photograph taken has an average of 4900 mm^2 documented, which would be equal to a square of 70 mm. With all these data, the number of photographs, the size and the shape of the font, the estimated error of the 3D model generated is 0.2 mm.

The use of different shutter speeds and lens apertures, combined with a correct number of photographs, the use a tripod and a correct horizontal and vertical angle, has made it possible to obtain a high-res 3D model for the analysis of the inscription and its decoration, which has allowed us to advance in the knowledge of this element.

Fig. 7 Final result of the photogrammetric reconstruction of the baptismal font

As Farella and Bisson-Larrivée have already shown in their studies [40, 41], the correct planning and use of camera parameters and their post-processing allow element with small details to be analysed in depth, without the use of intrusive methods such as moulds or tracings.

There are three remarkable elements in its decoration. Their details were captured before the restoration process conducted by Miguel Vázquez Arjona in some drawings that are part of the Intervention Report of the font [43] (Fig. 8) and have been recovered in the photogrammetric survey carried out as a result of this investigation (Fig. 9): some Spanish coats of arms (Figs. 8a–b, 9a–b), a face carved in stone in the elevation (Figs. 8c, 9c) and a belt finished in a buckle in the right quadrant (Figs. 8d, 9d). Thanks to the 3D analysis carried out, it has been possible to enhance part of the decorative elements, which, despite the restoration carried out by Vázquez Arjona in 1993, are deteriorated, such as the vine leaves, the belt or the head (Fig. 9). This has allowed us to analyse them in greater depth and in detail, identifying the carving traces of the font. In addition, it has been discovered that the shields were not completely facing each other, as the restorer alluded to. However, the most important finding has been, without a doubt, being able to unravel the transcription of the inscription on the band of the baptismal font. This fact, unknown until now, was not discovered even during the restoration process. Therefore, within this research the use of the photogrammetry as a tool enabled reaching three important findings: (a) obtaining a digital copy of the ancient font as it can be observed currently, that can serve for conservation in future restoration processes; (b) having the possibility of reading and deciphering the inscription found on the band of the baptismal font despite of its difficulty to identify some of the carving traces existing in it, and (c) analysing the spatial position of the decorative elements, making sections of them for its study without the need of obtaining moulds of the font.

The coats of arms (Figs. 8, 9) do not present any trace of reliefs on them. The time to which their elaboration is attributed coincides with the time of the union of House Priego and House Feria, by the marriage of the 2nd Marchioness of Priego. For this reason, it can be inferred that the coat of arms of Priego would be painted in one of the

Table 3 Results obtained in Metashape

N° photographs	Aligned photographs	N° Cloud points ($\times 10^2$)	N° Dense cloud points ($\times 10^6$)	Documented Area (mm^2)	N° Sides of the mesh ($\times 10^6$)	Resolution (mm/px)	Estimated error (mm)
603	603	342	33.4	2.98×10^6	6.7	0.18	0.2

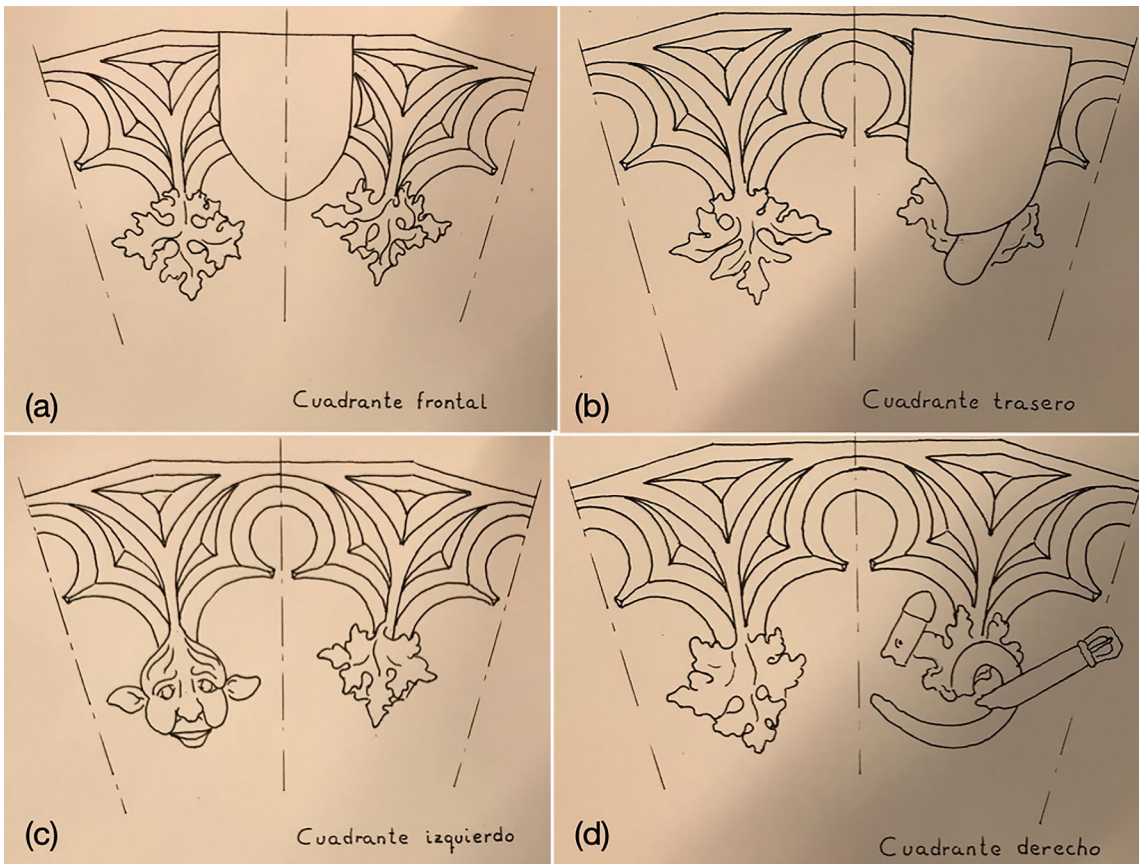

Fig. 8 Detail of the drawings of the coats of arms (**a** and **b**), the carved face (**c**) and the belt (**d**) in the Intervention Report of the baptismal font [43]

coats of arms, and that of Feria would be painted on the other.

In the Renaissance, there was a reform regarding the baptismal fonts which consists of reducing its size [3, 4], among other issues. Also human iconographic elements were commonly used in baptismal fonts, like a catechesis, as in the present case, in the font of Tobar, Burgos [46], Santa María de la Encina in Burguillos del Cerro, Badajoz [47], Aldealengua de Pedraza, Segovia [48], all of them in Spain; and in the rest of Europe in the Cathedral of Hildesheim, in Lower Saxony [49, 50], St.Nikolai, in Burg auf Fecharn and in Klosterkirche Church, in Bordesholm, in Germany [51]; St.James Park, in Piccadilly, United Kingdom [52]; Redemptoris Saint-Trond Church in Wellen, and Saint-Remy Church of Namur, both in Belgium [53]; Horgen Church, in Zürich, Switzeland [4]; the Trinity Horse Church in Gävle, Sweden [53]; the Capo-Don Church in Riva Ligure [53] or the St Ermolao Church in Calci [54], in Italy. In the province of Córdoba, for instance, there is the contemporary baptismal font of the church of Nuestra Señora de la Asunción, in Montemayor [42]. They included "heads or isolated, unconnected figures inscribed in arches, which do not usually form iconographic programmes" [55], as is the case of the baptismal font of the present study. It is a human face with deformed features, in a certain way monstrous. The authors of the present study think that it could be an iconographic element typical of ugliness [56], which was characteristic of the Romanesque and prevailed until the Renaissance, when the study element was made. There are numerous examples of this style, which are located in heritage buildings and elements, although they are geographically far from the study object. Among such elements, it is worth highlighting decorative elements in the Cathedrals of Santiago de Compostela and Burgos, as well as in the cloister of the Monastery of Santo Domingo de Silos.

The third element referred to is a belt (Figs. 8c, 9d). For Christianity, this symbolises moral virtues [57], which are reached through the Sacraments, such as baptism, and it also symbolises binding and loyalty [58]. It can also be related to the emblem of the Order of Saint Augustine (a leather belt with a buckle on an open book and a heart in flames), which settled in Montilla around the year 1520,

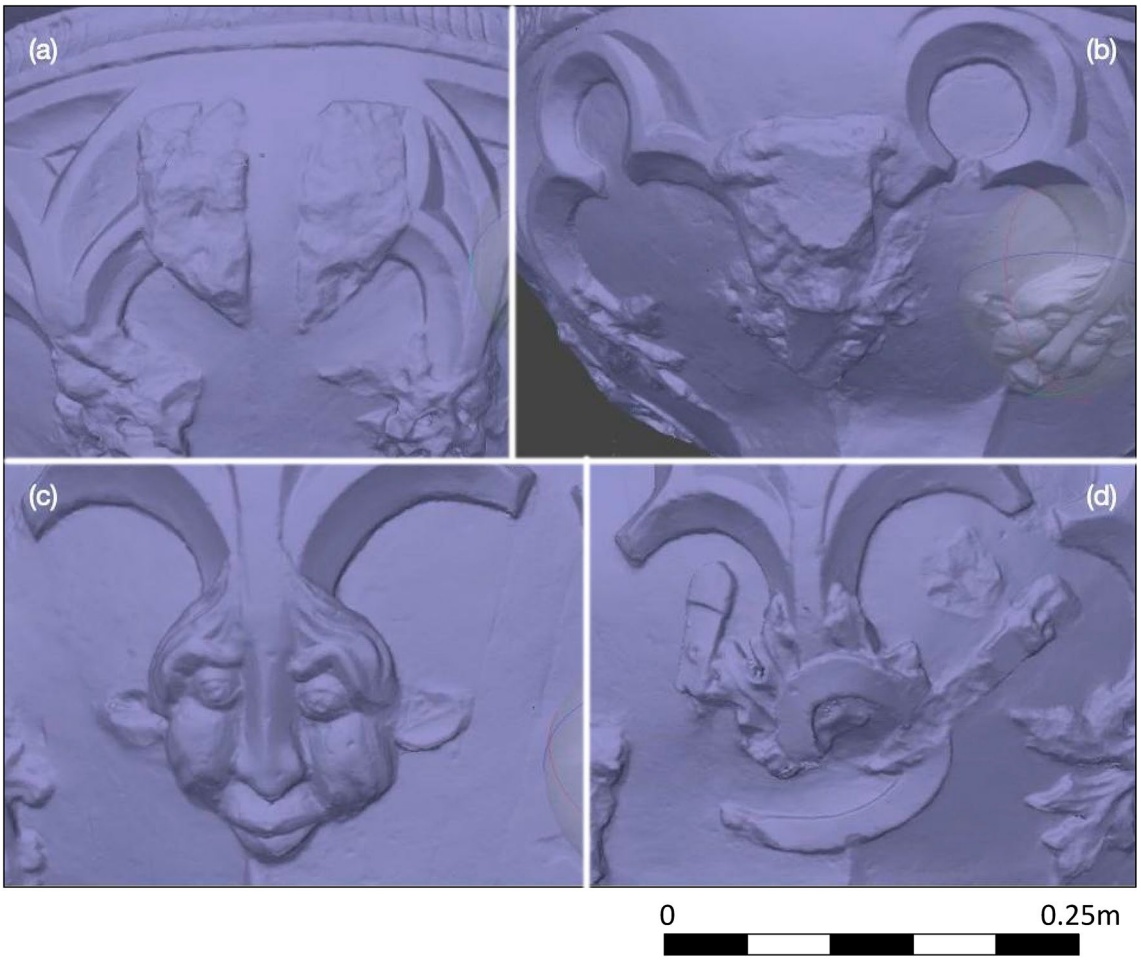

Fig. 9 Details of the scanning of the frontal (**a**) and back (**b**) quadrants

under the protection of the Marquise of Priego [59]. The Virgin Mary appeared to Santa Mónica, mother of Saint Augustine, and promised that those who wore the habit belt She gave her would be especially protected by Her. Thus, it is known as the Sacred Belt of Santa Mónica and Saint Augustine, being part of both the emblem and the habit of the monks of this Order [60] and being present in different heritage elements linked to the latter.

The drawing in the stone described here is greatly deteriorated, thus it cannot be accurately stated that this is the correct interpretation. Moreover, at the edge of the upper part of the font, there is a skirting board with a caption (Fig. 10). After analysing the 3D model and comparing its inscriptions with those of other baptismal fonts, it was possible to decipher them. This is one of the main finding of this investigation, since the inscription itself was unknown up to now, not even during the deep restoration process carried out by Vázquez Arjona was it discovered. The decoration of the band was alluded in the graphics made by the restorer, but without referring to any written legend. This is undoubtedly one of the most important contributions of this research. In addition, thanks to this discovery, it has been possible to enhance part of the decorative elements of the font, which despite the restoration that took place in 1993 could not be completely recovered.

The skirting board shown in Fig. 10 is disordered, with the inscription beginning in band BC "SECUNDUM MARCDUM (sic) ET EIS EUNTES" (According to Saint Marcus. And he told them). The inscription continues in band CA "IN UNIVERSUM MUNDUM PREDICATE EUANGELIUM OMNI" (Go all over the world and spread the gospel to every). Band AB finishes with "CREATURA QUI CREDIDERIT ET BAPTISATUS FUERIT SALVUS ERIT" (Creature. He who believes and is baptised, will be saved).

This inscription refers to the Gospel according to Saint Marcus, Chapter 16, verse 15 and part of 16. It

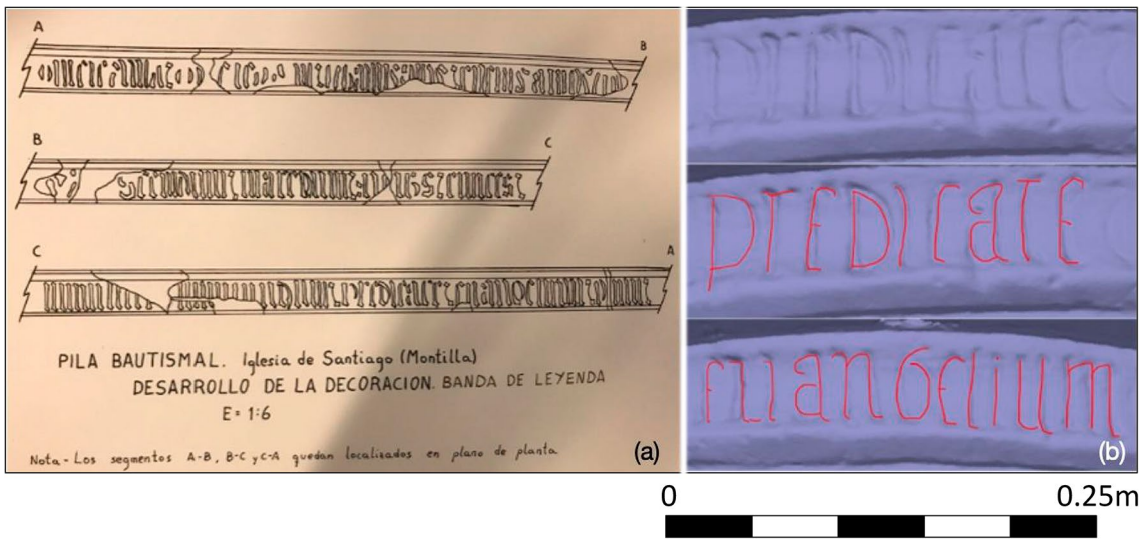

Fig. 10 **a** Detail of the decoration of the band of the caption [43] and **b** details of the scanning

is written in Latin in gothic letters, and there are two small changes with respect to the verse in Latin. Firstly, it reads Marcdum, but it should be Marcum; secondly, the order is changed in bands C-A, which read IN UNIVERSUM MUNDUM, but it should be IN MUNDUM UNIVERSUM. Both changes could be due to a small misrepresentation of Latin, as they belong to a very late epoch. It is part of the passage of the Ascension of the Lord, when Jesus once resurrected, entrusts his apostles with the evangelization of the world and salvation through baptism ("He who believes and is baptised will be saved", in the inscription text "CREATURA QUI CREDIDERIT ET BAPTISATUS FUERIT SALVUS ERIT"). We cannot forget that we are before a baptismal font, where the neophyte, through Baptism, is born to a new life.

This inscription is also found in the baptismal font of the parish of Santo Domingo de Guzmán in the municipality of Torres (Jaen, Spain). Similar inscriptions can be observed in other baptismal fonts, such as in the San Bartolomé church (Jaen, Spain), Cardiel Cave (Burgos, Spain) [61], several in the Rioja region (Spain) [2], and also in other countries. There are some in Germany: the one in St. Jakobi of Luebeck or St. Marien of Northern, both made in bonze. There is also the one of Notre Dame of Fourviére in Lyon (France) [62], among others. This piece dates from the late fifteenth century or early sixteenth century and it includes a band with a caption in gothic letters, although, in this case, it is written in old Spanish. It reads "Quien creyere i bautiçado fuere salvo será el que non fuere en verd (será condenado)" (He who believes and is baptised will be saved and not condemned), referring to the Gospel according to Saint Marcus, 16, 16. As can be observed, both fonts refer to baptism.

Study of the intervention process on the baptismal font

On October 20 1993, the Government of Andalusia and restorer Miguel Vázquez Arjona signed a contract to carry out the restoration of the font within 8 months. The Intervention Report, preserved in the parish of Santiago Apóstol, defines the preservation state as "terrible and much worse than initially expected", with numerous additions made with Portland concrete, as well as an applied ochre oil pigment imitating the colour of the stone [43]. Presumably, it is deduced that this treatment was performed when the baptismal font was moved to its new location, as is inferred from the testimony gathered in the journal *Eco Parroquial* of September 3 1916 [29]. The parish priest stated that "the almost-destroyed wooden coating of the font must be removed and replaced with a new one, which can be made of either concrete or another material susceptible to modelling in order to be adapted to the project" [63].

Regarding the study of the previous state of the font, ten drawings were made of the elevation, ground plan and decoration of the band of the caption, where details of its ruptures and wall canals can be observed (Figs. 8, 10), as well as the structural losses and cement additions. In the crown alone, there are over fourteen fractures, which are presumed to have been caused by involuntary actions. Moreover, humidity and a great loss of the original stone was discovered at the back of the font. It was uncovered during the first phase of the

intervention, which consisted in the removal of residues, as is detailed below.

An iron structure was uncovered, which was placed at some unknown time to support the stone fragments. According to the report, it was inserted "in such a drastic and aggressive manner that it caused new fractures and important losses". It consisted of two iron rings, 40 mm wide and 10 mm thick, one under the fringe of the caption and the other in the junction of the shank with the bowl, both joined by vertical plates. It was embedded under the stone and covered by canals opened from the exterior, which were in turn covered with concrete. This covering helped to the maintenance of the state of preservation of the iron structure. Moreover, in the interior, a canal was discovered, some 20 mm wide, filled with glass strips.

As stated in the intervention report, after this tedious process, the volume was reintegrated. Lime and sand mortar from calcarenites was used, thus obtaining some characteristics that were very similar to those of the rock in which the font was carved. Fiberglass was also employed, applying several layers, especially in the back, where they also placed, by way of staples, stainless steel wires to consolidate the filling, to which they also added small blocks of stone of characteristics similar to those of the original stone. They decided not to repair the inner pecking, as it did not affect, to a great extent, the appearance of the font or its religious purpose. Then, they carried out a colour reintegration, levelling the colour of the new parts applying a pigment wash to the pigmented lime.

Lastly, a layer of silicon resin was applied as waterproofing. It was characterised by the fact that it did not alter the appearance of the stone, while it provided benefits in terms of absorption and water repellence [22].

For its preservation, it was recommended that, in the face of any type of damage, qualified staff should be contacted before conducting any intervention in the future. Furthermore, it was highlighted that the environmental factors of the font (light, temperature, humidity) [64] and the changes in the rite of christening, which exempt the church from the obligation of keeping the font constantly full, "are not favourable", although special attention must be paid to the human factors. In this sense, the intervention report highlights that the font must be especially protected when works are carried out in its near surroundings.

The restoration process of the font, apart from enabling the preservation of the piece, allowed bringing the decorations of the lower part of the crown back to their original state, which are based on trilobed (Fig. 2b).

Indications of the preservation and restoration of the stone sculpture

Diverse factors can cause different lesions. Fort González classified them into four types: intrinsic, extrinsic, human and architectural factors [65]. Thus, mineral accumulation and dust or particle deposition can lead to the development of hard crusts on the stone, colour variations or loss of volume [66, 67]. Physical–chemical or mechanical actions can also result in a loss of material. Humidity and thermal changes can cause damage and even fractures in the stone [65]. Pollution is another of the most harmful factors [68–71]. Biogenic organisms such as lichens, algae and moss, or blisters in the stone, can burst and fracture the stone, leading to detachments due to the loss of cohesion of its materials or to other types of cracks of diverse origin, among others.

In recent years, restoration propositions have changed. It has been discovered that bacteria can be used as producers of bioconcrete, laser technique, which is not very effective [69, 72–76]. The protection of the environment and sustainability are reflected in the preservation of the cultural heritage. It is a priority to ensure eco-sustainable rehabilitations in especially protected buildings and heritage, as is the case of the parish of Santiago Apóstol in Montilla and its baptismal font.

For the baptismal font of the present study, as in every process of preservation and restoration of stone monuments, apart from the historical study, it is necessary to carry out a scientific-technical study [77]. The latter includes an analysis of the humidity and the environment, characterising the stone materials and their biodeterioration. This allows developing a coherent intervention proposition that guarantees the stability of the piece [77–79].

Limestone is subjected to a gradual process of dissolution, causing the progressive deterioration of the heritage built in it [80–84].

The elaboration of the 3D model of the baptismal font has helped to conclude that no new damage has been found in this cultural heritage piece. Here is the effectiveness of the restoration undertaken by Vázquez Arjona in 1993 and that has passed without any notoriety for science until now, but without which this important element for cultural heritage would have disappeared in a few years.

Conclusions

This study has taken as a base the baptismal font of the church of Santiago Apóstol in Montilla to demonstrate how documentary analysis and digitalisation of cultural Heritage is key to its conservation and Discovery of the new data that highlight its importance.

The restoration process of the baptismal font of the church of Santiago Apóstol in Montilla conducted by Cordovan restorer Miguel Vázquez Arjona is of great relevance. Thanks to him, it was possible to preserve this significant element of the heritage of the Catholic Church, where San Francisco Solano was baptised [6], and which has been seriously affected by different events throughout History, such as the 1755 Lisbon earthquake and its displacement from the baptistery in 1916.

The study of the University of Córdoba, which was not involve in the restoration process, allowed determining the origin and composition of the stone of the font. This is fundamental not only for the restoration process conducted by Vázquez Arjona, but also for its preservation. The techniques used for the preservation of stone monuments have varied throughout time, with some variations not always being the most appropriate alternatives. The restoration works of this baptismal font performed in the late twentieth century were key to bring this element very close to its original appearance, guaranteeing its preservation as an indisputable element of the historical–cultural heritage. Based on the graphic documentation gathered in the Parish Archive of Santiago and the results obtained by Calvo Serrano in his doctoral thesis [22], jointly with the 3D analysis built, it was possible to delve into the analysis and explanation of the iconographic decoration of the font, being able to discover and interpretate the written inscription of the baptismal font band. The authors have delved into a part of the study carried out by Calvo Serrano [22], investigating, and analysing a hitherto unpublished document: the memory of intervention on the baptismal font that is preserved in the parish archive of the church of Santiago Apóstol in Montilla.

Its digital documenting through photogrammetric techniques and its subsequent analysis using the Cloud Compare tools allowed understanding the iconography of the font: on the one hand, enhancing highly deteriorated decorative elements and, on the other hand, enabling the transcription of the inscription contained in the band of the crown. The methodology used, making use of photogrammetry techniques that have been well known for theirs and the study of Point Clouds through filtering and height studies, allow us to analyze inscriptions, lost decoration and we believe that its use can be applied to a large number of cultural heritage elements.

The realization of this 3D modelling of the piece, until now non-existent, is key for future studies in terms of its conservation and for its enhancement as a heritage element of an area of great tourist attraction. The 3D model allowed to continuing analysing its iconographic decoration and its significance. All set and reached objectives are linked in the framework of this research, since without the previous analysis of the restauration process and the decoration of the font, it would have been impossible to decipher and have a better understanding of the results obtained by the photogrammetry survey. Therefore, this innovative technique assists in the understanding of cultural heritage in general, demonstrating its usefulness in the enhancement and conservation of cultural heritage. In addition, and from the point of view of the heritage conservation, these non-invasive tools and techniques, such as photogrammetry, are put in value within this research to digitally conserve and preserve this kind of assets. This study paves the road for future research lines, aimed, firstly, to a more precise dating of the piece, secondly, to the identification of the author or workshop of origin. Finally, the methodology used for the analysis of the inscription and its 3D model can be used for the documentation and study of Islamic ataurique, column capitals, bases and inscriptions present in different monuments of Córdoba and its province.

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M-AC-S, PT-T, and F-PM-T conceived the research; RO-C, R-EH-F and F-JM-C analysed the data; M-AC-S, RO-C and PT.-T, writing and review. All authors have read and approved the final manuscript.

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Declarations

Competing interests
The authors declare that they have no competing interests.

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