Digital Turris Babel. Augmented Release of Athanasius Kircher's Archontologia

Francesca Condorelli, Barbara Tramelli, and Alessandro Luigini

1 Introduction

Given the importance stressed by UNESCO on the documentation and valorization of tangible cultural heritage, the aim of this project is to show scholars and citizen what they cannot see because it is enclosed within the pages of the book, i.e. the most noteworthy images of the *Turris Babel*. This was done thanks to the implementation of a workflow divided into more parts. The first part concerns the placing of the Opera in his context, the analysis of graphic illustration and the reconstruction of the tridimensional model of the tower. This represents the most challenging part of the entire pipeline as it involves creating a model of an imagined architecture that never existed and of which we only have a single representation.

By combining advanced photogrammetry and 3D modelling techniques, the model was created from the images in the text and compared with other designs of the tower. The second part of the software is the design of an augmented reality app to make the model of the tower navigable in 3D and available to the public.

Both the reconstruction of the tower and the implementation of the app were carried out with low-cost tools and using open source software, ad explained below.

Augmented reality is undoubtedly an excellent way not only for visual communication as a tool for knowledge but also to give an effective interpretation to tangible cultural heritage.

F. Condorelli · B. Tramelli · A. Luigini (✉)
Faculty of Education, Free University of Bozen, Brixen, Italy
e-mail: alessandro.luigini@unibz.it

F. Condorelli
e-mail: francesca.condorelli@unibz.it

B. Tramelli
e-mail: barbara.tramelli@unibz.it

A. Giordano et al. (eds.), *Beyond Digital Representation*, Digital Innovations in Architecture, Engineering and Construction,
https://doi.org/10.1007/978-3-031-36155-5_6

Markerless technology was used in the development of the application to make the experience more immersive and user friendly. Recent studies have shown that this technique contributes to the optimal levels of user interaction that are required in this type of experience.

2 Turris Babel

The Jesuit scholar Athanasius Kircher (Geisa, Fulda, 1602–Rome 1680) was an eminent representative of seventeenth century encyclopedism, as his eclectic interests ranging from the field of linguistic studies to geology, from philology to optics, to collecting antiquities testify to. Teacher, writer and philosopher, his rich collections of findings of classical, oriental, and Amerindian art constituted the museum collection known as the Kircherian Museum housed in the Collegio Romano (1651) [1]. Aside from the *Turris Babel* (1679), among his most important works we could mention the *Oedipus Aegyptiacus* (1652), the *Mundus subterraneus* (1665) and the *China illustrata* (1667). When looking at the surviving copies of some of these book, one could tentatively infer that some books such as the *Magnes Sive De Arte Magnetica Opus Tripartitum* (1650, 81 surviving copies) had a better fortune than books such as the *Turris Babel*. We do not know at present how many surviving copies there are, the ones we find online are in the Biblioteca, one copy is at the Biblioteca of the seminar in Bressanone, two copies at the Biblioteca Municipale de Lyon, three copies in the Bodleian Libraries, one at the Bibliothèque Nationale de France and one at the Pontificia Univeristà Greogoriana. The USTC catalogue, which does not list all the surviving copies of this book. The publisher, Johannes Janssonius van Waesberge, secured in 1661 the contract for the exclusively printing of all the work of Kircher for 2200 *scudi*. However, the latter is interesting in many respects, as it gives us a clear idea of the scholar's interest for the mysteries of the ancient world.

The book contains a beautiful fold-out engraving of the tower of Babel, as well as different representations of the magnificent city of Babylon, of Egyptian tombs and other marvels (including a pictorial map of the Tigris-Euphrates Valley from the Persian Sea to the Caspian). The architecture of the tower of Babel holds a prominent place among the illustrations presented in the book, and this is clear from the very beginning of the whole work, as when we look at the frontispiece to Book I (Fig. 1), which represents the planning of the tower's architecture, we see a scene with three allegorical figures in the act of studying the plan for the design of the tower, as if to supervise the works that are already taking place (as the sketch of the tower in the background shows).

As already noted by Peter Harrock, the frontispiece to Book I is exquisitely baroque in form and style. The evolution from the Renaissance frontispiece is evident, as the decorative architecture is abandoned in favor of an illustrated take on the episode, where all the figures are playing an active role in the designing of the tower [2].

Fig. 1 Frontispiece to *Turris Babel*, Book I, Athanasius Kircher, Amsterdam 1679 (Photo: F. Condorelli, B. Tramelli and A. Luigini)

From this first image, one can already derive the intent of the author of the book: *Turris Babel* is evidently a theatrical work, in line with the Baroque intents of dramatizing the narrative it recounts, and this is clear from this first scene which has all the figures (presumably the protagonists of the biblical episode, namely Noah, Nimrod and his son Ninus) playing their roles in classical costumes.

The second Frontispiece to Book II (Fig. 2) is what interests us the most, as it represents the whole architecture of the tower. It shows the tower extending towards the sky limit, embedded into an idealized landscape of the city of Babylon. The tower is presented as a giant construction whose grandeur is traditionally viewed as the symbol of human pride. As the biblical passage states:

"The whole world spoke the same language, using the same words. While men were migrating in the east, they came upon a valley in the land of Shinar and settled there. They said to one another—Come, let us mold bricks and harden them with fire. They used bricks for stone, and bitumen for mortar. Then they said,—Come, let us build ourselves a city and a tower with its top in the sky, and so make a name for ourselves; otherwise, we shall be scattered all over the earth. The Lord came down to see the city and the tower that the men had built. Then the Lord said: If now, while they are one people, all speaking the same language, they have started to do this, nothing will later stop them from doing whatever they presume to do. Let us then go down and there confuse their language, so that one will not understand what another says. Thus, the Lord scattered them from there all over the earth, and they stopped building the city" [3].

The tower is here conceived as a paradox: from one side it is meant to be a perennial construction, and on the other side we know that its fate is to be destroyed by God as a punishment for the *ubris* of men. Different pictorial examples show this duplicity, such as the famous Vienna Tower by Brueghel the elder for instance, who inserts in the painting incomplete elements and the decadence of the construction itself. In other examples, such as the one form the *Turris Babel*, the focus is on the beautiful and intricate architecture rather than on its unfortunate final destiny. This choice can be traced in other prints from earlier periods, as for instance in the illustrations by Bernard Salomon and Pierre Eskrich in Lyon printed one century before. If we look at the recurrent images they made for the printers of the city (namely Jean de Tournes and Guillaume Roville), we see that the intent is similar: showing the construction rather than the destruction (Figs. 3 and 4). In these two very similar images, the focus is on the chaotic and muddled process of the building, which is almost non-sensical but still very much active. In the *Turris Babel* [4] however, the image is more static, there are no people on the tower itself but rather on the foreground (recalling the scene of the first frontispiece). The tower is always a symbol of the un-finished, that is of something that cannot be achieved in its entirety.

This is clear in the engraving of the *Turris Babel*: the top is still under construction, and it looks almost like a ruin. The annihilation of the tower is implicitly hinted at, although it is not predominant in the picture, which is focused on rendering the majesty and the esthetic quality of the massive architecture, described here in the smallest details. Comparing it with other images, the picture of the *Turris Babel* seems more a celebration of the skillfulness of men rather than a chaotic attempt to

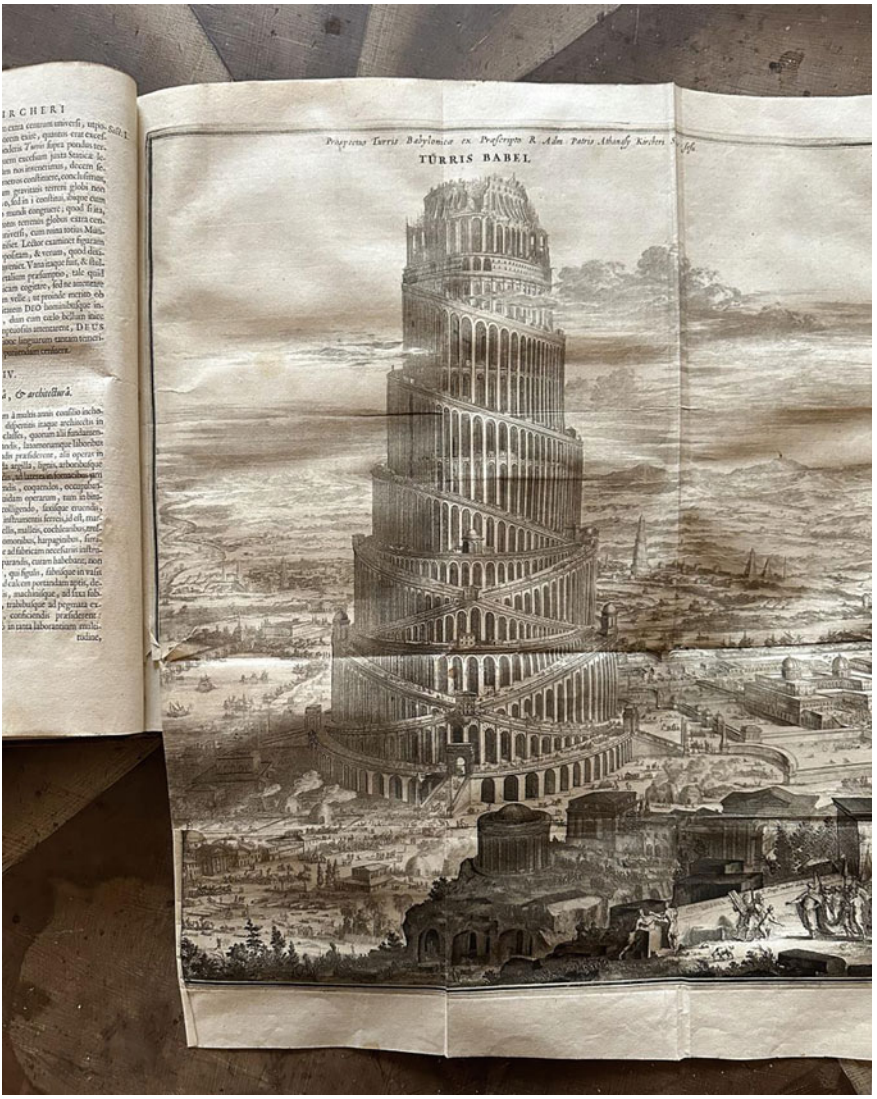

Fig. 2 Frontispiece to *Turris Babel*, Book II, Athanasius Kircher 1679 (Photo: F. Condorelli, B. Tramelli and A. Luigini)

surpass human limits. There is no real judgement here, but rather a visual attempt to describe the effort of men to unite themselves, an attempt that as we know failed, as the biblical episode was written to try to explain the multiplicity of languages on earth.

Fig. 3 Bernard Salomon, The Building of the Tower of babel, woodcut. *Source* Les Quadrins Historiques de la Bible, Lyon, De Tournes, 1553 (Photo: B. Tramelli)

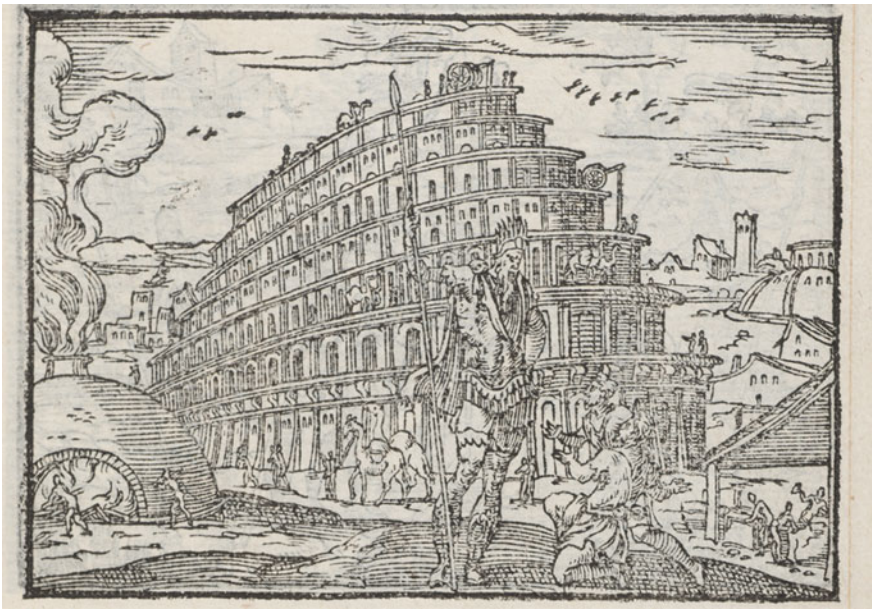

Fig. 4 Pierre Eskrich (also named Vase, or Cruche), The Building of the Tower of babel, woodcut. *Source* Les Figures de la Bible, Lyon, Roville, 1564 (Photo: B. Tramelli)

3 Methodology

The methodology used was designed to solve the specific problem of the three-dimensional representation of a known work of architecture by means of some graphic representations made from the descriptions contained in the biblical scriptures (Fig. 5).

Following a detailed explanation of the workflow is reported. First of all is was necessary to expand the database of images available on the tower. For this reason images similar to the one in the text were taken from web crawling. Starting from this dataset, the photogrammetry workflow was implemented to extract known points that were useful for reconstructing the model (Fig. 6).

The photogrammetric software used in this work is the open source pipeline of COLMAP. he standard SfM sequential processing pipeline for the iterative reconstruction in COLMAP was customised [5] in order to extract the coordinates of specific points in the images. The presence of some specific known points, selected by the human operator, will allow the correct modeling of the object of study.

The first step of Feature detection and extraction find sparse feature points in the image. After a preliminary automatic selection of feature points, point of interest for the next phase of the metric evaluation are manually selected with an additional step of Manual selection of feature points (highlighted in red in Fig. 7) was added, after the Feature detection and extraction phase in order to guarantee the presence of tie points in the point cloud to use during the subsequent Feature matching and

Fig. 5 Proposed workflow (Editing: F. Condorelli, B. Tramelli and A. Luigini)

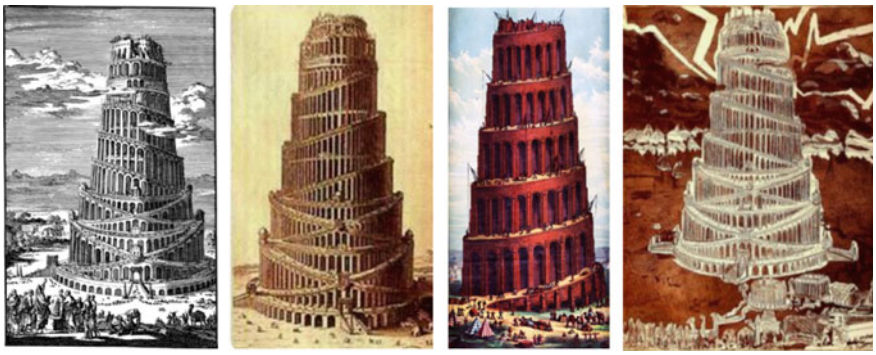

Fig. 6 Some images of the Babel Tower from image retrieval step. *Source* web crawling

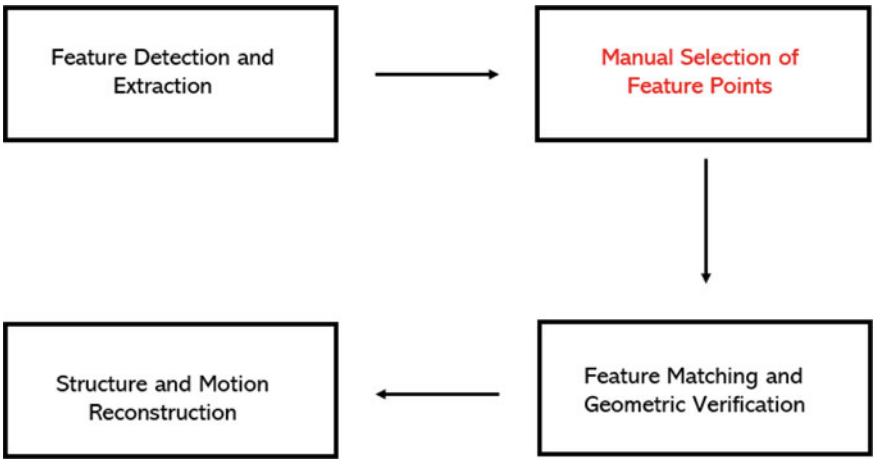

Fig. 7 The customized photogrammetric pipeline (Editing: F. Condorelli, B. Tramelli and A. Luigini)

geometric verification step. In the third step, Feature matching and geometric verification find correspondences between the feature points in all the images. As result of the matching, a point cloud is obtained with the Structure and motion reconstruction step. Although being sparse, it includes the points used for the 3D modelling of the object of interest. For what concerns the second phase of the proposed workflow, the development of an Augmented Reality is undoubtedly an excellent way not only for visual communication as a tool for knowledge but also to give an effective interpretation to tangible cultural heritage. Markerless technology [6] was used in the development of the application to make the experience more immersive and user friendly. Recent studies [7] have shown that this technique contributes to the optimal levels of user interaction that are required in this type of experience [8].

4 Results

Thanks to the detection of specific points in the photogrammetric step, the 3D models of the tower and the labyrinth from the book's illustration were created (Figs. 8 and 10). Following the results of the AR apps developed for the Athanasius Kircher's Archontologia are shown. Thanks to the implementation of Vuforia tool in the Unity environment, the app shows the navigable model of the tower in real time by simply pointing the device at the corresponding image in the book. Vuforia is a cross-platform platform for augmented reality and mixed reality app development with robust tracking and performance on a variety of hardware (including mobile devices and head mounted displays (HMDs)) (Figs. 9, 10, and 11).

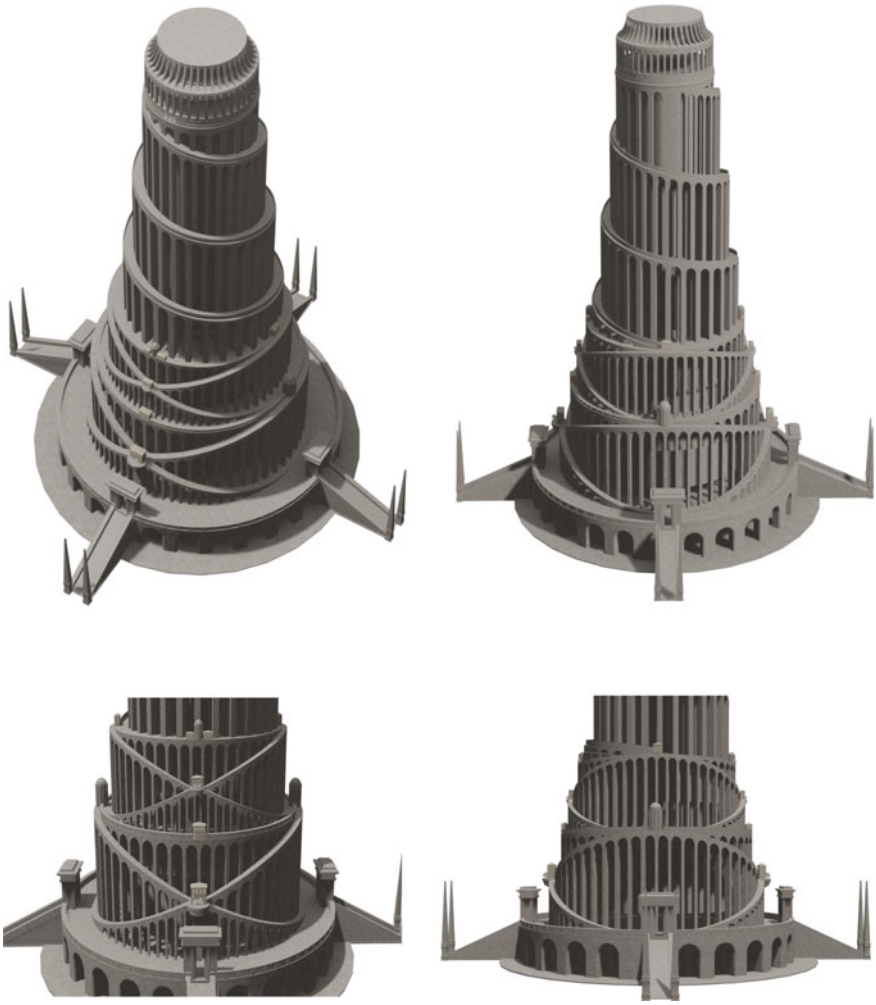

Fig. 8 3D model of the tower (Editing: F.Condorelli, B. Tramelli and A. Luigini)

Vuforia's integration with Unity enables the creation of apps and vision games for Android and iOS using a drag-and-drop creation flow. In AR, markers are images or objects stored in the application that serve as triggers for information in the application. When the device's camera detects these markers in the real world (while running an AR application), it triggers the display of virtual content at the marker's global location in the camera view. Tracking with markers can use different types of markers, including QR codes, reflective physical markers, image targets, and 2D labels. The simplest and most commonly used type of marker in gaming applications is the image target.

Fig. 9 AR app for the visualization of 3D model of the Babel Tower (Editing: F. Condorelli, B. Tramelli and A. Luigini)

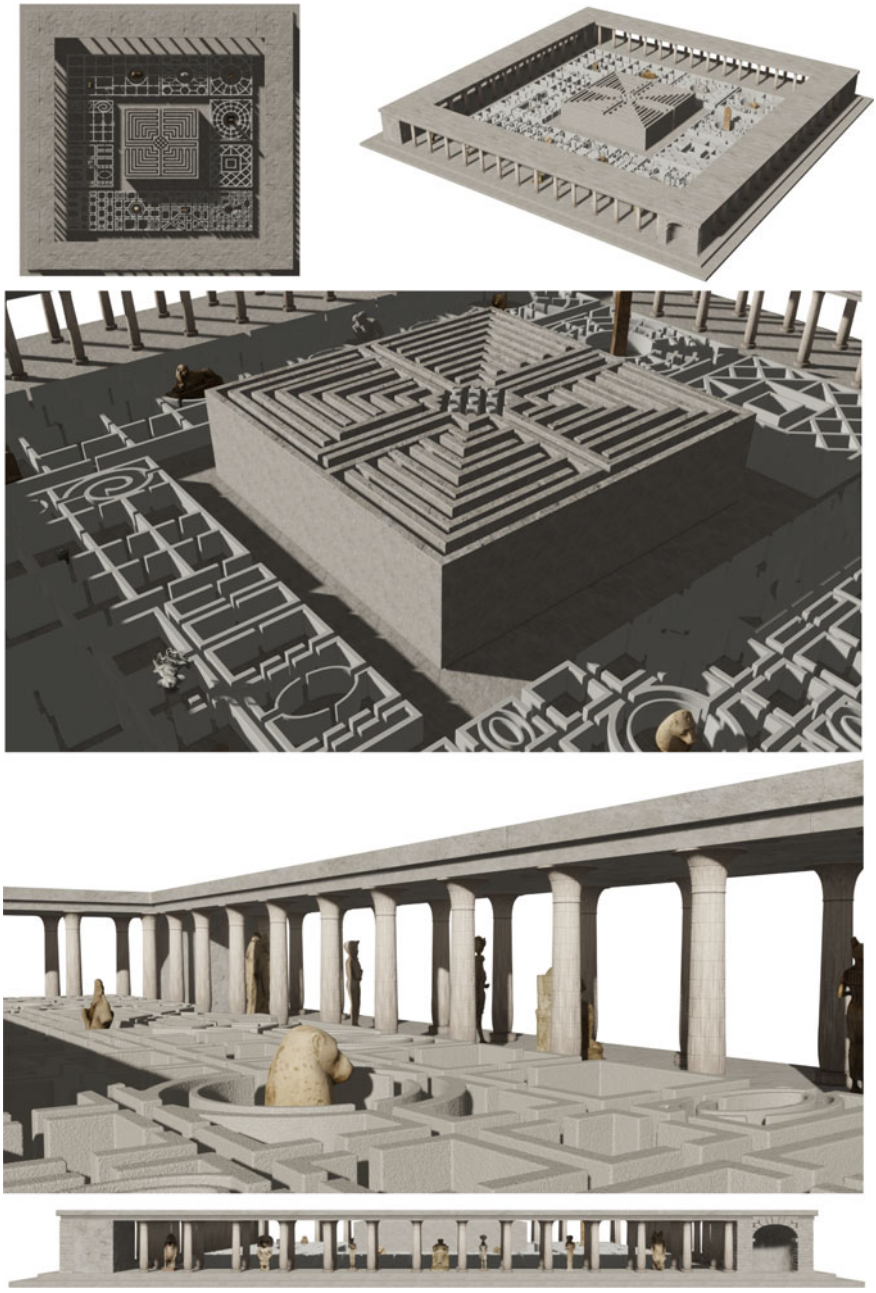

Fig. 10 3D model of the labyrinth made (Editing: F. Condorelli, B. Tramelli and A. Luigini)

Fig. 11 AR app for the visualization of 3D model of the labyrinth (Editing: F. Condorelli, B. Tramelli and A. Luigini)

5 Conclusions

The augmented navigation device will be optimized and the narration of the book content and illustration descriptions will be improved to ensure a smooth and engaging experience of the book. Future research will explore the use of visual search engine algorithms in combination with AI. Moreover the improvement of the matching phase in the proposed workflow using recent algorithms such as SuperGlue could be a good solution for the obtaining of the 3D model of imagined architecture as the *Turris Babel*.

References

1. Treccani website: https://www.treccani.it/enciclopedia/athanasius-kircher/, last accessed 2023/03/31
2. Harrock, P.: Inseminate architecture: an archontological reading of Athanasius Kircher's Turris Babel, Doctoral Thesis, McGill University (1992)
3. Vatican website: https://www.vatican.va/archive/ENG0839/__PD.HTM, last accessed 2023/03/31
4. Turris Babel, sive Archontologia qua Primo Priscorum post diluvium hominum vita. archive.org, last accessed Feb 2023
5. Condorelli, F., Higuchi, R., Nasu, S., Rinaudo, F., Sugawara, H.: Improving performance of feature extraction in SfM algorithms for 3D sparse point cloud. Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLII-2/W17, 101–106 (2019)
6. Hammady, R., Ma, M., Powell, A.: User experience of markerless augmented reality applications in cultural heritage museums: MuseumEye as a case study. In: De Paolis, L., Bourdot, P. (eds.) Augmented Reality, Virtual Reality, and Computer Graphics. AVR 2018. Lecture Notes in Computer Science, vol 10851. Springer, Cham (2018)
7. Palma, V., Spallone, R., Vitali, M.: Digital interactive Baroque Atria in Turin: a project aimed to sharing and enhancing cultural heritage. In: Luigini, A. (eds.) Proceedings of the 1st International and Interdisciplinary Conference on Digital Environments for Education, Arts and Heritage. EARTH 2018 (2018)
8. Shih, N.-J., Diao, P.-H., Chen, Y.: ARTS, an AR tourism system, for the integration of 3D scanning and smartphone AR in cultural heritage tourism and pedagogy. Sensors **19**, 3725 (2019)