Digital Techniques for the Accessibility and Promotion of Historical Buildings: A Case Study of the Former-Yugoslavian Embassy in Tirana

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Digital Techniques for Documenting, and Interactively exploring Historical Artifacts: A Case Study of the Former-Yugoslavian Embassy in Tirana
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Abstract. Urban identity is formed as a result of the stratification of diverse historical structures. In this sense, its important understanding, and showcasing these layers of architectural heritage. Today, rapid advancements in digital technologies, including 3D modeling, virtual reality (VR), augmented reality (AR), and online accessibility, facilitate the identification and promotion of cultural heritage. These technologies can bring into life historical objects or artifacts in places inaccessible to the public or objects that have been lost and no longer exist. Considering the substantial transformations occurring in our cities, wherein the loss of significant architectural structures cannot be discounted, digital techniques assume great importance.

This research focuses on the villa located on Durrës street in Tirana, build during the Italian period, in a neoclassical style and known as the "Former Yugoslav Embassy". It stands as one of the few remaining buildings from that era. The research project seeks to explore innovative digital methods to digitally delve into this architectural heritage. By employing these methods, the general public and professionals can access historical information, use archival materials, and virtually explore the villa. This interactive experience is enabled through a 3-dimensional web application, allowing users to interact with the space from different points of view and view the object in both its current state and historical version. The study comprehensively outlines the entire process of conceptualizing and developing this web application.

Keywords: Virtual heritage, 3D modelling; historical phase documentation; interactive exploration; Web application;

1. Introduction

An important part of the urban character that strengthens the sense of community is its history. To recognize, preserve and promote this history, is essential knowing and appreciating historical buildings. Today, thanks to digital technologies, the identification and promotion of cultural heritage is developing rapidly. Digital technologies such as 3D, VR, AR as well as online access are bringing to life buildings or historical artifacts have been lost or no longer exist and are making them accessable in places inaccessible to the public.

In the case of Tirana, there are many buildings of historical and architectural significance that have been demolished, without even leaving time to document them. These buildings may be an example of a particular architectural style or represent an important period of urban history. One of the few buildings that stands still and is in good conditions is the Villa on Durrës street, known as the "Former Yugoslav Embassy". This villa was built in 1931 (Bushati, 2012, Vokshi 2022), commissioned by Doctor Qemal Yusuffati but soon changed its function. In the thirties, it was used as the Turkish Legation and from 1945 it was used as the seat of the Yugoslav Embassy (Bushati, 2012). In recent times, although the building has been restored and is in good condition, it has been abandoned, risking decay and demoliton, to become a construction plot like many villas of the Italian period or traditional ottoman house in Tirana.

Nowadays, the wide availability of the Internet and web access, has enable cultural institutions to digitally document and show architectural heritage to large public or professional audience (Zara, 2004). The availability of high-speed internet and the widespread use of mobile applications on Android devices, as well as web and desktop applications for Windows and Mac, have made it highly attractive to interact and share content. This is particularly pertinent for museums and archive institutions (Kavoura & Sylaiou, 2017). 3D visualization technologies represent not only a method of simulating the actual world in 3D, developing a realistic environment (Ch'ng, 2013), but also a tool to digitally preserve physical artifacts that are at risk of being lost (Novitski, 1998). Additionally, they enable users to access information more effortlessly compared to traditional methods due to the immersive nature and various multimedia features such as text, sound, images, animations, and movies (Petridis et al., 2005), facilitating implicit learning (Kargas et al., 2022). This form of digital access bridges the gap between the physical building and its docuemntation, making exploration easier and offering more insight to the possibilities of preservation and reuse from professionals.

The challenge of this research is to define a methodology for providing online access to archival documents and data related to the former Yugoslavian Embassy, with the possibility to extend it to other historical buildings. This involves developing a user-

friendly interface that allows interactive exploration in virtual reality (VR) and integrating appropriate IT tools and tailored software for this specific purpose.

2. Research methods

The proposed methodology involves four primary stages: conducting historical research and documentation, surveying the building and defining its different historical periods, processing and modeling the data, and creating a web application with information and VR (as illustrated in Fig. 1).

Figure 1 Methodology: the four main step

- Documentation of a historical building mean the collection of data concerning the object of study, including historical research, archival, direct survey and creation of a digital archive. During this phase, relevant information, including the building's usage and alterations, will be compiled.

- Assessing the current situation (field survey) involves taking measurements and creating drawings of the building's current state. Additionally, using this information along with historical records, other historical phases will be visually reconstructed.

-Creating the 3D model involved using Rhinoceros 6 and 3D Studio Max initially to assess compatibility with interactivity programs. After careful evaluation, 3D Studio Max was selected due to its optimized design, high quality, and ease of use in game programs without compromising quality. The model was crafted with meticulous attention to detail, especially in replicating all decorative elements of the facade. At this stage, lights, materials and textures were added.

-Planning and designing interactivity involved thorough research to establish the interface structure, technological framework, and development methodology for the development team. Various comparable cases were examined, including 3D web interfaces showcasing galleries, museums, and architectural objects.

3. Historical research and building documentation

Historical research on the former Yugoslavian Embassy building focused on examining archival materials, conducting on-site observations, and undertaking a comprehensive literature review. This process involved studying historical photos, videos, original project documents, reconstructing the existing situation and the changes made to the building over time, as well as historical maps and written records, which provided details of the building's history and development.

The villa, known as the former Yugoslavian Embassy, is situated on "Durrësit" street (which at the time it was build was named Viale Principe di Piemonte[1]). It embodies the Italian architecture of the 1930s, displaying a blend of eclectic motifs in the Venetian neo-gothic style. The main façade facing Durrës street was adorned with elaborate decorations, while the back part exhibited a modernist character, foreshadowing the rationalist Italian style of the 1940s. The villa was constructed in an almost new area of Tirana with scarce presence of building. During this time, the affluent class started building urban villas infused with a totally new spirit, under western influence (Bushati, 2012). Historical maps and aerial photographs[2] were crucial in understanding the villa's urban surroundings. During the communist period, Durrës Street was completed with linear buildings, occasionally punctuated by existing villas or low-rise structures. However, after the 1990s, there was a noticeable shift towards replacing many low-rise buildings with high-rises. Specifically, the areas to the north and west of the villa saw the emergence of high-rise buildings, altering the villa's urban context and diminishing its significance as a prominent landmark along the Durres Street.

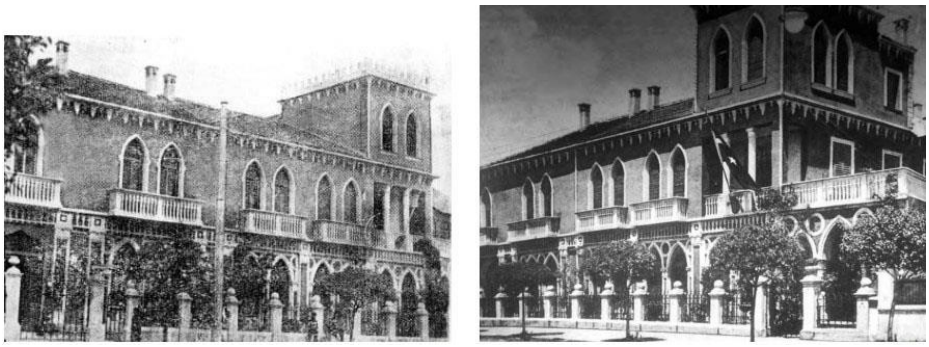

Figure 2 a) Turkish Legation, 1931; b) Postcard of the villa in the period when functioned as the Turkish Legation, 1939 (source; in Vokshi, 2022)

The original project drawings (Fig.3), historical photographs dating back to the 1930s and 1940s (Bushati, 2012; Vokshi, 2022), as well as images from the Italian digital archive "La Luce"[3] consistently depict a neo-Gothic facade. These images reveal

[1] See Tirana map from the survey of 1927-1938
[2] https://geoportal.asig.gov.al/
[3] https://www.archivioluce.com/

gothic arched windows and intricate ornamental details on the main facade of the villa. The villa consists of two main floors and a smaller third floor on the left side. The ground level has two main entrances: one is designed with an Arab-Moorish arch and spans a larger area and the other is adorned with a portico supported by two Corinthian like columns, sustaining three gothic arches—two smaller ones on the sides and a larger central arch serving as the entrance to the portico. On the first floor, windows and doors open onto four small balconies and a lateral terrace corresponding to the portico. Additionally, the first floor features a loggia separated by two columns on the facade. Moving to the second floor, the facade is characterized by double arched windows on both the front and side walls. This section is topped by a decorative system with blinds. Photographs of the villa until the 2010s depict a similar appearance, indicating that most of these facade elements have remained unchanged, at least in their formal aspects. However, the historical photos do not provide a comprehensive view of the back of the building or how it has been altered.

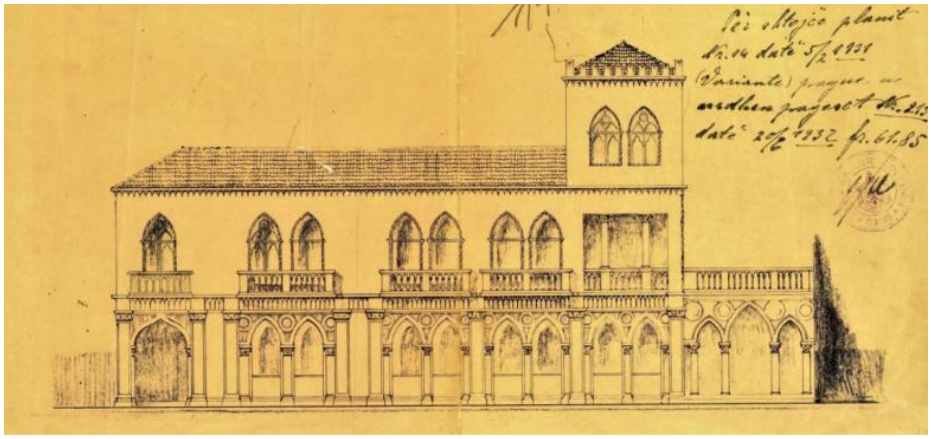

Figure 3 Facade of the original project of the villa (source: National Building Archive)

Historical archival research has revealed transformations in the villa over the years. Initially designed as a residence for the Jusufati family, the building served as the Turkish Legation from 1939 and later as the Yugoslav Embassy after 1945. Despite its deteriorated condition in recent years, the building was intermittently repurposed as an exhibition space. However, in recent times, it has been left entirely abandoned.

The villa has experienced alterations in its facade, particularly at the rear. While there are no photographic records from historical periods, archival plans indicate a significant change in its volume (Figure 4). Nevertheless, the original blueprints suggest that the rear facade was likely as plain and unadorned as it appears today. This aligns with architectural approach of that period, where greater emphasis was placed on the main facade visible from the street.

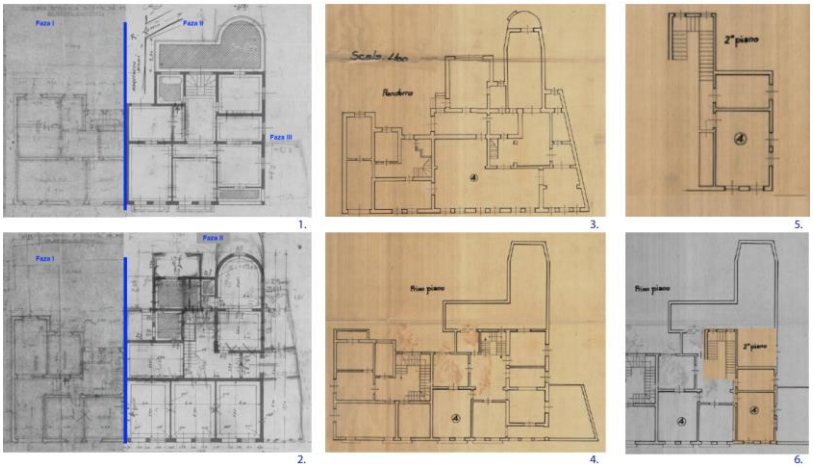

Figure 4 a. Facade of the original project of the villa; b. Floor plan according to the original project drawings in two main phases c. Final plans of the Jusafati house, but slightly different from the completed project (source: National Building Archive)

The main facade, which is the most adorned, compared to today's condition, has undergone only a few minor changes. From an architectural point of view, the volume of the third floor does not present today the ramparts, which turn out to have been present until the photos of the year 2000. Other changed elements are the window frames, which today retain similar shapes in the upper part but have been replaced with white duralumin. Additionally, the lower part's treatment of window frames with wall arches is now absent, and the shutters on the doors and windows are no longer there. The secondary entrance once had an iron protective net with Gothic arches, which has since been removed, although we were able to reconstruct it from film footage from the 2000s. Moreover, the exterior plaster color of the building has shifted from ochre to dusty pink, as has the color of the fence railing. Some modifications have also been made to the front terrace.

Figure 5 a. Photo of the former Yugoslav embassy, 2005 (source: wikimapia.org, online access, 09/2022); b. Photo of the former Yugoslav Embassy, 2022 (source: author)

From the inside, the building today is not only transformed compared to the original project, but also in a degraded state. Most of the interior partitions have been destroyed and it is impossible to reconstruct the interior spaces and their use at different times. The surfaces of the walls are bare, without plaster. The floors are missing tiles and the ceilings are apparently beamed. Some parts of them were replaced with metal beams during the reconstruction. Also, internal concrete stairs on the ground floor and metal stairs on the first floor have been added. Today, both floors have a fairly large space without partitions corresponding to the windows of the main facade.

These transformations took place mainly between 2011-2012, when the building was restored by the company "Smart B. Invest". Although in 2007, the building was declared a Cultural Monument of the second category[4], the restoration was not done according to rules and legislations. Historical photos and footage from the 2000s allow us to reconstruct only the main and the side facade of the building in its previous state, before the restoration of 2011-2012. The rest has undergone so many changes that in the absence of historical evidence it is impossible to reconstruct.

3. Field survey

Actually, the surveys of historical buildings are carried out mostly with the use of laser scanning technology for 3D modeling of cultural heritage objects with high accuracy and within a short time (Serna et al, 2015). However, in this case, instead of employing laser scanning, a direct survey method was chosen due to its cost-effectiveness and quicker data processing for the 3D modeling phase. This approach involved using a meter laser for the building's overall structure and detailed photographs for capturing decorative elements. The detailed photographs were strategically taken to ensure an orthogonal projection, making it easy to trace and replicate the decorations accurately.

The villa comprises three floors and a small underground cellar accessible via an external staircase. The ground floor features a spacious area corresponding to the main facade, with two smaller rooms at the back, totaling 400m2 in size. The stairs and elevator room added later, are situated on the right side near the entrance with a portico. On the ground floor, the windows and doors are damaged, lacking original shutters and having new frames made of duralumin. The walls and ceilings' plaster, floor tiles, internal partitions indicating specific functions, and doors are missing. Additionally, the newly installed stairs connecting the floors are incomplete, lacking tiles or balusters.

The first floor also consists of a large open hall covered by a new metal construction roof. On the right side, there are two connected rooms with access to a loggia on the main facade. A large terrace is located on the back, and another terrace is positioned

[4] Decision No. 122, dated 05.03.2007 of the Ministry of Tourism, Culture, Youth and Sports

in front of the stairs visible on the main facade. The second floor can be reached via recently installed metal stairs, leading to the only area featuring two Gothic windows on the main facade. This floor spans approximately 60m2 and provides access to a sizable veranda located at the rear of the villa.

Figure 6 Direct survey of the building and details (Source: author)

The front facade closely resembles the original design in terms of architectural elements. However, some decorative elements around the windows, which were visible in old photos, are missing. The window frames have been simplified compared to the original ones, and one of the entrances is lacking the decorative metal net. Additionally, the higher section of the building is not adorned with ramparts as in the original plan.

Figure 7 Ground floor, first floor plan and main façade of the former Yugoslavian Embassy, from 2022 survey (Source: author)

The villa is enclosed by walls and a fence along the street. The fence is made up of columns and metal railings. The columns, like the building,

are painted in matching facade colors, while the railings are painted black. The fence has remained almost identical to the original, with only the color of the columns and railings changing from green to black. Due to the renovations done in 2011-2012, the eastern facade now has an expanded volume to accommodate the stairs. The most significant alterations are found at the back, which can only be identified by comparing the original floor plans with the current ones, as historical photos do not depict the rear facade.

4. Historical-building 3D models

The 3D model was developed by analyzing the building's current state starting from floor plans, facades, and section drawings, and focusing mainly in the external envelope of the building. Initially was build a detailed 3D model of the building in its current state, encompassing all intricate decorative facade elements. Subsequently, using this model, multiple adjustments were made to recreate the original hypothetical phase, visible until at least 2011. The reconstruction of the pre-restoration condition was based on the initial project, along with historical photos and videos. In both cases, particular attention was given to the primary facade elements and their alterations across different periods.

The model was generated using 3DStudio Max due to its capability to handle intricate geometric forms and numerous decorative elements while managing the model's complexity. Various ornamental features of the building, including arches, orders, columns with capitals, frames, and balusters, were designed using basic geometries that were parametrically transformed into complex shapes available in 3ds Max, such as cubes, spheres, cylinders, pyramids, spirals, and arches (Zara, 2014). These shapes were initially converted into polygons by adjusting, adding, or splitting vertices and applying certain modifiers. By employing these techniques, objects with intricate shapes could be created (Kelly, 2014), closely resembling the original elements while maintaining a lightweight structure. To optimize the model's weight, especially for repetitive elements, the "instance" command was utilized. Additionally, decorations that were challenging to measure, like frames, were modeled based on photographs taken from various angles, ensuring accuracy and fidelity to the original design. This was crucial because the model will be uploaded to web platforms, enabling real-

time interaction. To place real image materials, standard textures were used, such as plaster with the same color, the roof texture, greenery and trees, etc. They are applied to the designated surfaces according to real images. The 3ds Max material editors were utilized to apply materials, allowing precise adjustments of properties like color, reflection, transparency, and collision maps. Once the model was finalized, light sources were strategically positioned within the scene to create lifelike lighting conditions, emphasizing the architectural details of the main facade.

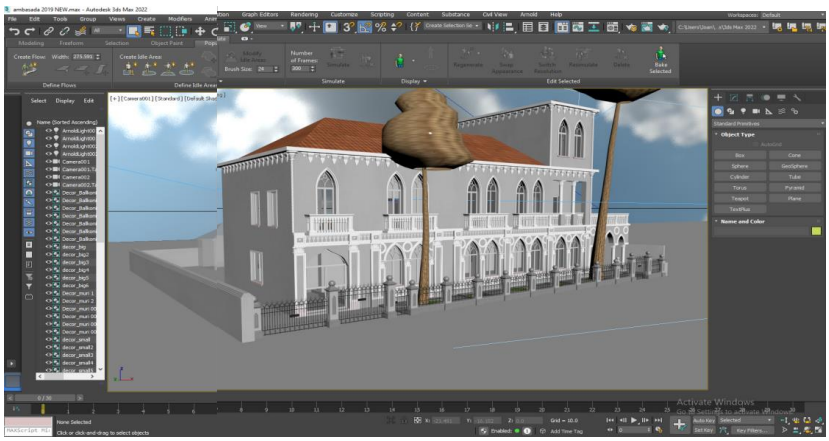

Figure 8 3D model in 3D Studio max

The model is exported in GDL format, a choice favored by web developers for various reasons. GDL (Geometric Description Language) format allows essential information extraction for display on a 3D web platform. It facilitates geometry optimization and conversion to compatible formats like OBJ or glTF, enabling real-time rendering in a web environment and the creation of interactive 3D models for web applications.

5. Design of interactivity in virtual heritage application

Virtual Heritage, driven by institutions such as museums, galleries, libraries and archives, utilizes the capabilities of contemporary technologies in visualizing and presenting cultural objects beyond text, borrowing ideas from the game industry (Addison, 2000). Virtual heritage applications combine digital technologies with cultural

heritage to create immersive and interactive experiences for users. According to Rousseau (2002) representation, experience and interaction are the main digital components of virtual heritage. The use of virtual heritage increases the motivation to use technology to obtain information, knowledge and training (Limniou, 2008) and to do it in an easy way.

Visual design plays also an important role in creating attractive apps. It includes not only the digital representation of the historical building, an aesthetic interface with graphic design elements such as color schemes and fonts, but also user experience (Hoffman and Novak, 1996). User experience and interaction play a crucial role in these applications, as they allow the user to actively engage and explore objects in virtual space. Other elements that make the application attractive are the 3D models that are seen as information systems, which display data of different natures (historical, architectural, material, constructive and environmental and offer the possibility to access them easily). These interactive elements enhance user experiences, facilitate learning, and foster a deeper understanding and appreciation of cultural heritage. Interaction design involves also designing interactive elements and behaviors within the virtual environment. It defines how users can interact with objects, retrieve information, and navigate through the virtual space. In this regard it's important to create intuitive and user-friendly interfaces (UI) that facilitate easy navigation and interaction within the virtual environment. Well-designed interfaces improve accessibility and allow users to seamlessly engage with digital heritage content.

Figure 9 Web/mobile application: Interactivity and User Experience Design (source: https://dev.division5.co/yugo/)

In the case of the villa of the Former Yugoslav Embassy, interactivity on the web platform will include different aspects of navigation:

Figure 10 Different aspect on interactive navigation: Time models; First person and free navigation; navigate in hotspots.

1. *Time travel.*

Time-travel to different periods of the building is still one of the major challenges for Virtual Reality technologies related to the cultural sector (Laumos et al. 2018). In this project, the user can seamlessly transition between two distinct historical periods of the building (new and old referring to the current and prior to last restoration), both meticulously recreated in 3D within the web application interface. Users can delve into the 3D model of the historical structure, gaining profound insights into its evolution just selecting the historical period. Moreover, interactive hotspots allow them to access detailed information about the modifications occurring to the building, especially referred to elements of the main facade.

2. *Switch between "First-person" navigation and free navigation*

Users have the option to select their preferred mode of navigation by pressing navigation bar. First-person navigation allows users to walk and experience the virtual tour from the perspective of human eye's height, as if they were physically present next to the building. This mode enables users to freely navigate through the virtual environment, exploring diverse areas and elements from their perspective. This constitutes an advantage compared to looking around as in the case of panoramic images (Zara, 2004). User can use keyboard controls and mouse movements to navigate through the virtual space. This navigation mode has the option turn head, rotate object of interest, go ahead/back, pan, change camera optics, jump to another viewpoint (Zara, 2004). This provides a more immersive and interactive experience, allowing users to feel as though they are personally exploring the historic building. Notably, the building's fence serves as an obstacle to movement, compelling users to enter the building's courtyard through an opened door, mimicking real-world scenarios.

Free navigation gives users complete control over their movement within the virtual environment. They can move in any direction, pan the

camera, zoom in or out, and explore the building at their own pace. This type of navigation allows users to freely move around and interact with different elements or points of interest and at different heights as well as change viewpoint in any direction.
These navigation forms are especially useful for users who want to probe deeper into specific areas or look at details closely.

3. *Interactive elements on the facade of the building or hotspots*

The facade of the building presents some interesting elements from an architectural point of view or "hotspots" with which the user can interact. Users can click on these points to get information, view detailed photos or technical drawings for the item they click on. By selecting these elements of the facade, the view will be enlarged and the user can have a series of information that can help us understanding of the architecture and history of the building. These hotspots can either remain visible during navigation or be hidden, allowing an unobstructed view of the building.

4. *Information content*

Information content includes description text under different categories such as building description, history, context, existing condition etc. By clicking on it, a new window will display all the information on the object categorized according to the stages of historical documentation. (Fig.11a). The more specific informative content will appear as a preview on the left of the screen, in the section dedicated to information, and could be explored gradually by clicking on it (Fig.11b).

Figure 11 Information content windows a. General informative content to explore by clicking INFO; b. Specific informative content to explore gradually (source: https://dev.division5.co/yugo/)

6. Bukargailding the WEB platform

To build a simple web platform for virtual heritage exploration based on a 3D model navigation, were followed the following steps:

-Discovery phase

The discovery phase involves collecting information and identifying the project requirements and objectives. During this phase, architects, digital content creators, and developers collaborate to define the platform's essential features. The crucial points included the possibility for time travel navigation, videogame like space exploration and large audience targeting. Key aspects involve enabling time-travel navigation, game-like exploration of space, and reaching a broad audience. Specifically, the web application is designed for use by scientific researchers, architects, historians, as well as individuals interested in Albania's architectural heritage.

-Solution architecture

Based on the project goals, user typology and stakeholder input, the main elements of functionality that the web platform were identified, were 3D model rendering, interactive navigation controls, information display, the ability to switch to the historical model. To implement the solution, we considered different alternatives for front-end development and chose React.JS, a well-known JavaScript library due to its flexibility and large developer community. This would help the project and the application in a moment that will need to be further developed in the future. Since our goal was to create a 3D experience, we decided to use Babylon.js for displaying 3D graphics and animations in the browser. Babylon.js provides a wealth of features and tools for creating interactive 3D experiences. With virtual legacy applications, where the focus is on rendering 3D models of legacy objects, Babylon.js provides a complete set of APIs, shaders, and rendering capabilities, enabling developers to create high-quality 3D environments visual and interactive.

The combination of React.JS for front-end and Babylon.js for 3D offers a good and flexible solution to create a web platform, as they are compatible with each other. Babylon.js can be used inside React.js components to manipulate 3D models, providing a good integration of 3D elements in the application.

Determination of work standards
For managing the work throughout the technical development phases of the project was chosen *Scrum* methodology, which provides an organized, flexible and collaborative structure to build the application as well as the teamwork. It provides transparency, accountability and helped to have a better and faster progress of various technical aspects to be developed. In the case of this project, the flexibility this technology enables allows teams to respond to feedback, incorporate new ideas, and make adjustments based on user needs or evolving technologies.

Architectural and structural details
During this stage, the architectural elements of the web platform were delineated. Initially, was drafted the page structure with the 3D model as the main window. Subsequently, a structured hierarchy was established, organizing information into categories and subcategories for user accessibility. Icons, labels, buttons, libraries, images, and templates were then seamlessly integrated. Since the application didn't involve overwhelming data processing, a backend integration was deemed unnecessary. Consequently, our attention shifted to task allocation and implementing effective communication methods between the front-end and the 3D component, ensuring the seamless functioning of our web platform.

WEB platform building
During the web platform building stage, we focused on developing both its front-end and 3D components. On the front-end, were integrated images, buttons and library. Concurrently, using Babylon.js, we integrated 3D graphics and other elements into the platform, crafting an interactive user experience. This construction phase led to the successful completion of both facets of the web platform.

Coding and implementation of the web platform encryption
Throughout the coding and structural development phase, were maintained high coding standards to ensure clean, consistent, and easy-to-understand and maintain code. We adhered to neat syntax, appropriate naming conventions, utilized independently reusable modules, and provided essential comments and documentation to clarify our code's functionality. The application underwent rigorous

testing to ensure high quality and optimal performance of the platform. By maintaining these coding standards, is ensured an orderly and consistent structure to code, making it easier to manage, extend and maintain in the future.

WEB platform implementation

The implementation of the web application is divided into various phases. Initially, the work was focused on the development of two aspects of the application, the front-end and the presentation of 3D models with the corresponding interactions. Subsequently, both of them were integrated into the web application. During this phase, our focus was on merging and synchronizing the front-end components with the 3D aspect of the platform. We ensured that both parts were coordinated and communicate with each other to provide optimal user experience.

Web platform launch

The final stage of the project is launching the platform online, and make the WEB application available to users. During this stage, we thoroughly reviewed all the findings and outcomes from previous stages, ensuring the platform's readiness for launch. We first published it on a local server to test and fix any bugs identified to ensure a high performance and smooth operation of the platform. Then, we published the platform on a dedicated server and in a domain specific to the project.

7. Conclusion

The present applied research provides valuable insights into the methodology and challenges associated with the development of a web-based virtual heritage application.

In the initial stages of the research were undertaken historical investigation and surveying of existing buildings. A pivotal aspect was the creation of a compelling narrative and a detailed timeline documenting the transformation of the building over time. This phase demanded an accurate representation of the building, achieved through accurate creation of existing and historical 3D models.

Subsequently, the focus shifted towards optimizing user experience and interactive exploration, particularly in the realm of Virtual Reality (VR). This involved the strategic implementation of interactive

elements, intuitive navigation features, and engaging multimedia content toenhance user engagement.

One of the central challenges faced in this research was the design of a web application that seamlessly integrates real-time exploration of 3D content with information-based content. This integration demanded specific coding skills, and continuous collaboration between architects and development team.

In conclusion, this research not only sheds light on the intricate process of developing a web-based virtual heritage application but also underscores the significance of integrating historical research, accurate 3D modeling, user experience optimization, and development of 3D VR application. By addressing these challenges, the study opens new avenues for the creation of immersive and educational virtual heritage experiences in the digital age.

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