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3D MODEL VISUALIZATION FUNCTION FOR RESPONSIVE WEB DESIGN

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ABSTRACT: Except for critical basic implementations seen in historical records, the abundance of similar frameworks, platforms, and apps available may be deceptive. Striking a balance between 3D certified displays its a basically vital tool for today's quantitative simulation science. Since the seeing is the main sense for humanities. and incorporated complicated features continues to be difficult. Geometrically precise point clouds and meshes are the result of cutting-edge methodology (computer vision, reverse engineering, and digital photogrammetry), this technology (LiDAR, laser scanners, and unmanned aerial vehicles), and random research approaches. These represent random research approaches a by-product of the procedure.. As the precision, size, and complexity of these things rise, the capabilities of present technology to manage them deteriorate. In this research, we present a way for creating a low-cost 3D visualization platform that can perform tasks interactively. Moreover, we seek to verify the methodological aspect of implementing steps and simplified algorithms in a virtual reality like , the CGA module was used, which is a procedural methodology; by using MATLAB software is based on the procedural modeling methodology, which is based on the creation of an algorithm with rules according to what you want to obtain as parameters in the final modeling. Thus, the development of the 3D modeling generation algorithm begins, containing the necessary rules for the automatic calculation of the parameters.

Keywords: CAD, 3D, Web, GIS.

1. INTRODUCTION

Virtual reality, 3D graphics, and digital items may now be imagined without the need for costly equipment or specialist software. Their pervasive presence on the internet has led to a bigger audience's comprehension of the third dimension. The sector's most significant assets are now being emphasized by relying on customer familiarity with them. Tangible legacy 3D models are very beneficial, not only to subject matter specialists, but to anybody who can understand their natural and cultural qualities. Its inherent communicability reveals how it may be used to a wide range of cross-disciplinary tasks, including geometric documentation, diagnostic and monitoring, conservation, and risk assessment for natural disasters. Due to the fact that 3D representations serve as a common platform for all parties involved (professionals, researchers, institutions, and organizations), these efforts benefit from an increased collaborative component. This is because the three-dimensional representations enable the integration and synthesis of a wide variety of methods, strategies, and activities. As a result, they have a broader range of uses for the cultural heritage community in terms of publishing and online distribution. It enables remote access, real-time collaboration, content updates, and future-oriented regulations. When ancillary documentation data and textual material are included with the visualization, the potential for cross-disciplinary cooperation is maximized [2].

Advances in high-performance computers, web technologies, and computer graphics have transformed visualization methodologies [2]. Innovative techniques such as three-dimensional visualization and animation have had a huge influence on how information is presented today. The addition of a third dimension and dynamic information allows for a considerably more detailed view and comprehension of objects. Numerous industries, including engineering and interactive multimedia, have benefited from 3D visualization technologies. The advantages of 3D visualization are readily apparent in applications of geographic information science, which is unsurprising considering the field's emphasis on geographic data (GIS), the GIS means Geographic Information System, commonly known as GIS, is a powerful technology that allows for the capture, storage, manipulation, analysis, and visualization of geographically referenced data. It combines various types of data, including spatial, tabular, and attribute data, to provide insights and solutions for spatial analysis, decision-making, and resource management [3]. Due to its extensive usage, various applications and cutting-edge technologies for the display and analysis of the three-dimensional

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environment have been developed (Figure 1). Virtual three-dimensional city models represent a significant achievement in the area of geographic information systems three-dimensional applications. They provide a more nuanced understanding of the spatial properties of numerous urban objects. Additionally, they are establishing a single platform that will bring together a number of information sources in order to make city-level data more accessible. Due to their resemblance to real-world objects, 3D representations of city objects make them simpler for humans to perceive and study. These 3D models simplify the perception and study of city objects, allowing humans to better understand and analyze spatial data. Let's consider an example to illustrate this concept. For example, a city planner tasked with designing a new urban development project. The planner needs to assess the impact of the proposed development on the existing cityscape, including buildings, roads, parks, and infrastructure. Using GIS, the planner can create a 3D representation of the city, incorporating accurate spatial data and attributes. With the 3D model [3], the planner can visually analyze the potential impact of the new development from different perspectives. By overlaying the proposed structures onto the existing cityscape, the planner can assess how the new buildings will fit into the surrounding environment and evaluate their impact on the skyline, sightlines, and overall aesthetics.

Since its popularity grew, people from academics and industry have turned to virtual 3D city models to assist them in resolving real-world challenges [4]. Due to their widespread use, they are found in almost every field, from urban development to natural resource management to disaster management and beyon [4,5]. Finally, we can say the primary objective of the proposed study is to create capabilities for implementing computationally intensive algorithms, such as 3D buffer analysis, utilizing the WebGL API and a web browser that supports HTML5.

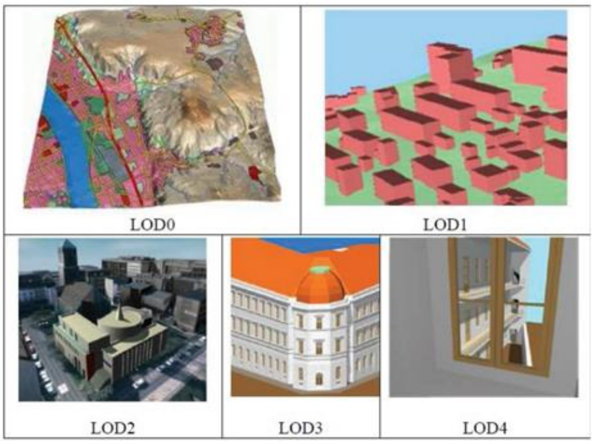

FIGURE 1. - LOD examples in a 3D scene [5]

2. RELATED WORK

This section delves further into a variety of research and case studies. The first of them is a comparison of several WebGL implementations, while the second is a comparison of few WebGL implementations. This thesis' investigation also encompasses the examination of related maps and ideas. Thirdly, we have intriguing research on photorealistic texturing in video games. Additionally, the next four sections demonstrate how various web-based tools and frameworks have been effectively used in practice.

2.1 Implementing A Specific 3D Web Application

A student at the University of Uppsala finished a master's thesis. This Master's thesis will investigate the most promising WebGL frameworks for constructing 3D online applications with game physics without the need of plug-ins. Additionally, it compares and contrasts the various WebGL 3D libraries available. As a result, we were able to match the various libraries to a previously determined set of criteria. Something comparable to what was utilized in this project, but with its own set of criteria and preferences... A game was developed using the two libraries determined to be the most appropriate for the criteria. The game's objective was to compare the performance of several 3D rendering libraries while using realistic game physics to represent the environment. One may infer that the combination of Three.js and Physi.js provided the best answer for the application's requirements.

2.2 Ambient Occlusion

At Linköpings University [in Swedish], a Master's thesis [9] was completed. The master's thesis project's objective was to provide a viable implementation of methodologies for controlling ambient occlusion for dynamic objects and procedural settings. Even though this thesis was not written in a browser, a lot of concepts relate to this circumstance. For instance, lighting and shadows are explored in length, as are 3D methods such as ray-casting. The abbreviation SSAO (short for "Screen Space Ambient Occlusion") refers to a revolutionary approach that uses the depths of surrounding pixels rather than the depths of the pixels themselves to estimate an approximate ambient occlusion in real time. This service is offered for free or for a nominal fee.

2.3 Photorealistic Texturing

A student finished a bachelor's thesis on the issue at the University of Applied Sciences in South-Eastern Finland. This project's objective was to create real-time rendering simulations for usage in modern video games. For my thesis, I examined texture mapping and devised a method for achieving photorealism in video games in order to develop them. Both real-time rendering and three-dimensional texturing are employed in video games, and hence the same ideas apply. Along with being an intriguing subject, a wide array of linked concerns will be beneficial in some manner. Consider the following examples of related topics: Photorealistic materials may be made utilizing a number of normal/light/reflection/transparency maps and texturing techniques [10].

2.4 IKEA - Home planner

Ikea has created a browser-based planning tool to assist you in creating your ideal kitchen, workspace, and other areas [10]. Both the rigorous attention to detail and the high level of craftsmanship are easily visible. You may change the appearance of an area by dragging and dropping things into it. One minor disadvantage is that it cannot be utilized on mobile devices or phones due to the plug-in need. Users may use the tool in a variety of ways, while still being beginner-friendly and using the website's well-documented tutorials and FAQs area.

2.5 Three.js

Using the Three.js framework [16, 17], we can create a realistic incandescent bulb [17]. The following example illustrates a situation in a straightforward manner. There are many models in the scene, each with its own set of textures that distinguishes it from the others. A light source in the shape of a lamp and a wood-textured floor complete the impression. By engaging with a graphical user interface (GUI) on the computer, the user may adjust several lighting properties such as shadows, brightness, and hemisphere radiance. The scene's light source, in contrast to the bulb, is a hemisphere light, while the bulb's light source is a single point light.

2.6 Babylon.js

This is an example of the Babylon.js library [2], which can be found on GitHub. Each of the model's three rings has distinct materials and features. Naturally, there is an aircraft in the center of the image. At any point during playback, the user has the option to make significant modifications and updates to the scene. The scene is created using physical-based rendering technologies. No major frame dips are seen in the visualizations at any point in time.

2.7 Xeogl.js

Model that is more detailed as a result of the use of several materials. As seen in the accompanying code, this example illustrates how the Xeogl.js framework may be used to display a more complicated helmet model. Physically based materials, such as the one presented, are used to give the object in the example a more realistic look. GL Transmission Format (glTF), an acronym for GL Transmission Format, is a standard that enables the real-time transfer and loading of 3D models and sceneries. To enhance the model's look, we will employ a reflection map in this case.

3. COMPUTER GRAPHICS AND GIS

The design process, and more specifically the design process in architecture, has been and continues to be the focus of a substantial amount of research that is of a theoretical as well as methodological nature. The objective of this thesis is not to construct a synthesis of the studies that have been stated above; rather, it seeks to locate the position that computer graphics holds within the context of this process [6].

The process of developing landscape projects can, in many circumstances, be rather sophisticated, and as a result, it requires a framework that is comprised of a range of computer graphics methodologies and techniques. What we mean when we talk about "computer graphics" refers to the modeling stage, which is followed by the stage of project representation in a following step after the modeling stage has been completed.

Modeling is the process of bringing an idea, a concept, or a desired product to life in a digital environment. This can be done by creating a digital representation of the idea, concept, or product. During this phase, we will be developing a model of the information that we plan to convey or portray in the final product [7].

On the other side, representation is the process that is referred to as "rendering," and it consists of graphically displaying a visualization of the element that was modeled in the stage before this one. This visualization is based on the data that was collected during the modeling stage.

The strategies and procedures of computer graphics that are utilized in landscape projects today will be classified as falling into one of two categories: two-dimensional computer graphics, also referred to as "2D" computer graphics, and three-dimensional computer graphics, also referred to as "3D" computer graphics.

The possibility of confusion between the design process by understanding the distinctions and emphasizing clear communication, documentation, and collaboration, you can mitigate confusion between the design process and modeling approaches in 3D GIS projects., which can be segmented into the creative activity followed by the activity of representing the modeled part, and the modeling approaches, which can be summed up as the utilization of design support software [8].

The design phase of a landscape construction project is characterized by an iterative approach. We start with the data from a specification, which describes several features of the element in great depth. Some of these properties include the element's morphological, aesthetic, and functional characteristics, among others. To put it another way, the parts of the requirements serve as stand-ins for the problem or problems that need to be fixed. Then, after going through a series of processes, we get closer and closer to finding a solution. During these steps, the designer uses his cultural roots, his referent models, his skills, and his imagination to construct an element or a combination of elements that are suited for the request [9].

The modeled piece needs to be viewable at a variety of different periods all throughout these progressively more sophisticated stages of design in order to effectively show the evolution and advancement of the concept. The representation needs that reveal themselves on either side of the "problem/solution formulation" pairings are what we will be examining in relation to Figure 2.

In the field of landscaping, providing a visual account that is clear and understandable for the components that have been modeled is the objective of the representation process. Because of the graphic depiction, the designer is able to "freeze" his design at a specific point in time, which enables him to offer the formalization of a solution to a specific problem. It also makes it possible for sponsors and any other parties interested in the project to understand it, which paves the way for them to evaluate it and actively engage in the design process. In this regard, it is necessary to convey throughout the length of a project that the graphical representations are available to everybody and everybody [10]. This is because this aspect of the project is integral to its success.

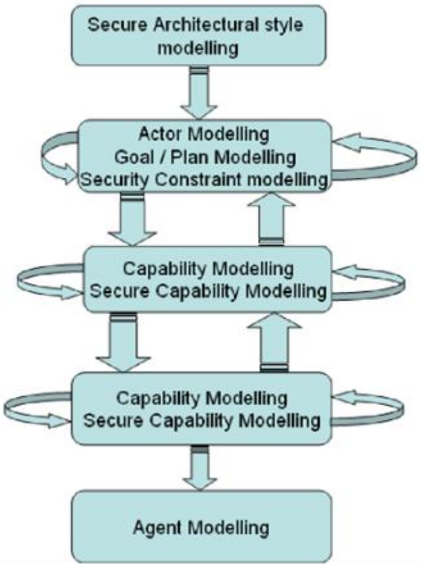

FIGURE 2 Architectural project development process

The most common modes of representation are certainly those in two dimensions such as plans and sections, whereas 3D representations appear today as recent visualization methods that are still difficult to use from a practical point of view.

4. THREE-DIMENSIONAL COMPUTER GRAPHICS

It is important to keep in mind that this thesis does not deal with any manual three-dimensional modeling methodologies such as perspective drawings or physical models, and it will not deal with any of these techniques in the future either. The modeling phase and the representation phase of computer graphics design are the only two phases that will be covered in this article's discussion of computer graphics design methodologies and techniques. The use of computer tools is required at both of these stages in order to complete them in their entirety [11].

The process of "three-dimensional modeling" can begin with dimensioned blueprints and be completed with CAD modeling software or by extracting computer data from CAD/CAD software. The term " three-dimensional modeling" refers to the process of "three-dimensional modeling," which is referred to by that term.

Modeling is the process of digitally portraying an object (or a combination of objects that constitutes the project) by providing an accurate description of the volumes or surfaces that make up the thing that is being modeled. This can be done for a single object or for all of the objects that comprise the project. It makes sense that the description can only be understood in light of all three spatial dimensions. When modeling in three dimensions, you must first sketch an element along all three coordinate axes, which are denoted by the letters X, Y, and Z. The modeling reveals the length, depth, and height of the thing or piece that is being modeled [12].

As a direct consequence of this, we now have a model that has wiring. This mesh, which is made up of individual points (called vertices) and lines (called edges), as well as edges, and faces is a representation of the framework of the project (vectors connecting these vertices). After this step, the resulting polygons are turned into faces, which, when added together, reflect the volumes of the many different objects that are depicted in the image.

It is possible to give an image that is closer to reality and to allow everyone to visualize the project thanks to the means of representation in three dimensions that are gained through modeling. This is possible both for the sake of giving an image that is closer to reality and for the sake of allowing everyone to visualize the project.

Even if they make it possible to communicate the three-dimensionality of the project, the majority of these modes of representation can still be viewed on supports that are only in two dimensions. This is the case even though they make it possible to express the three-dimensionality of the project. Following this, you will be taken on a tour of the different ways in which the computer tool can depict three-dimensional space in its many guises [13], the dimensions of the elements (such as the building, the greenery, the furnishings).

Perspectives (in the form of drawings or picture montages) (in the form of drawings or photo montages) The model in virtual reality Films or animated videos on a video player

The fields of real estate development and building construction utilize the word "perspective" to conjure the image of a view of a project that generates the sensation of having depth. This image is conveyed through the usage of the word "perspective." The majority of the time, the designer that realizes the perspectives will make an effort to transcribe the future development as it will be once it has been completed. In addition to this, it will be necessary to ensure that the scale of the site, the dimensions of the elements (such as the building, the greenery, the furnishings, etc.) [14], and the materials that are used are as fair and accurate as is possible. This will be necessary to ensure that the scale of the site, the dimensions of the elements (such as the building, the greenery, the furnishings, etc.), and the materials that are used [15].

The observer is able to acquire a deeper comprehension of the volumes that may be discovered at the area as a result of the viewpoint. There are numerous perspectives, such as the linear perspective, which contains two points that are regarded as "real vanishing points," and the cavalier view, which is frequently confused with axonometry. Both of these perspectives are examples of the many distinct viewpoints that are available (2). The natural perspective is the one that is used the vast majority of the time since it provides the sensation of depth and its vanishing points refer to the actual location (Figure 3).

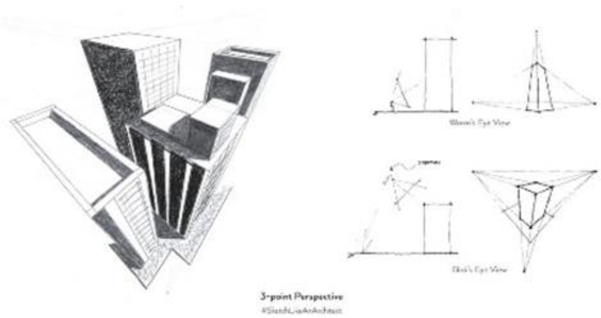

FIGURE 3 Diagrams representing three types of perspectives

To obtain a perspective, several methods are possible.

- From a photograph of the existing site: photomontage technique
- From a chosen view of a virtual model modeled in 3D
- From a manual drawing then embellished with the help of graphic retouching software. This manual method will not be described as it is a method of representation that is not fully infographic.

5. RESEARCH METHODOLOGY

Through the development of modeling guidelines that incorporate WEB-GIS and parameter analysis procedures into the use of CAD, the focus of this research is on facilitating better decision-making in the context of urban management. As a consequence of this, one of our goals with regard to the application of 3D modeling is to achieve the capability of deriving parameters that can serve as a directing component for various difficulties associated with urban planning. In GIS, 3D modeling is used to derive various parameters that describe the characteristics of objects or phenomena in the three-dimensional space. For example, (Geometry and Shape): 3D modeling enables the representation of the geometric properties and shape of objects in the real world. By creating 3D models of buildings, terrain, infrastructure, or natural features, parameters such as height, width, length, volume, area, and shape characteristics can be derived [14, 15]. As a direct consequence of this fact, the procedure referred to as Design Science Research (DSR) was decided to be the one to use for the process of generating this study. In the below, some points that explain how the DSR can be applied in the context of 3D modeling in GIS:

1. Problem Identification: DSR starts with identifying a specific problem or opportunity. In the case of 3D modeling in GIS, this could involve challenges related to visualizing and analyzing spatial data in three dimensions, understanding complex spatial relationships, or facilitating decision-making processes.
2. Artifact Design: DSR involves designing and developing artifacts that can address the identified problem. In the context of 3D modeling in GIS, this could involve designing new algorithms, methodologies, or software tools that enable the creation, manipulation, and analysis of 3D models within GIS environments. The artifacts could include 3D visualization techniques, modeling algorithms, or user interfaces tailored for spatial analysis in three dimensions.
3. Artifact Construction: Once the design is finalized, the artifacts are constructed, implemented, and integrated into existing GIS systems or developed as standalone tools. This phase involves the technical implementation of the proposed solutions, ensuring their compatibility and functionality within the GIS environment.
4. Evaluation: DSR emphasizes rigorous evaluation of the artifacts to assess their effectiveness and utility in addressing the identified problem. In the case of 3D modeling in GIS, evaluation could involve conducting user studies, comparing the performance of the new artifacts with existing methods, or assessing the impact of the artifacts on decision-making processes.
5. Knowledge Contribution: DSR aims to contribute new knowledge and insights to both the design and research communities. In the context of 3D modeling in GIS, this could involve publishing research papers, presenting findings at conferences, or sharing practical guidelines for using the developed artifacts in real-world scenarios.

Therefore the research using DSR addresses two distinct types of problems: practical problems, which require a change in the world so that it more closely aligns with the goals of decision makers related to the problem; and knowledge problems, which require a change in our understanding of the world. DSR is a method of research that addresses both of these types of issues [16]. The purpose of dynamic systems research, or DSR, is to make the world a better place by creating and studying artifacts that make it possible to alter the current state of affairs into situations that are more favorable or desirable. Getting a grasp on the nature of the (issue of 3D web application) is the first step in achieving this goal.

This strategy makes use of artifacts that have been developed with the objective of finding solutions to problems that are existent in the real world. Because of this, it is feasible to develop a theory that is coherent within the parameters of the study that is being conducted.

The problem of pragmatic validity is an aspect that is exclusive to research that focuses on DSR and is one of its distinguishing features [17]. This relates to the requirement of doing tests to determine whether or not the artifact that was developed is useful and whether or not it generates the outputs that were hoped for [18]. Following this, the products that have been developed are evaluated based on criteria such as how valuable they are or how useful they are [19]. Constructs, models, procedures, and instantiations are the four categories that can be used to categorize these artifacts, which may even lead to an upgrade in theoretical understanding. This can be accomplished by categorizing these artifacts using these four categories.

In the end, a method will be established as an artifact, and during the whole of the research, it will be referred to as WEB-GIS integration guidelines. In order to provide some type of practical validation, bibliographic research and an empirical study were used, using the software that was referred to, in the modeling of the Sadr City area that is located within the city of Baghdad. This was done in order to develop this method, which was afterwards employed in the process of developing this method further.

5.1. RESEARCH STEPS

When conducting an SLR on the methodology used for creating a 3D model of GIS (Geographic Information System), the following steps can be undertaken:

Defining the Research Question: Clearly articulate the research question or objective of the SLR. For example, the research question might be: "What are the methodologies used for creating 3D models in GIS?"

Search Strategy: Develop a comprehensive search strategy to identify relevant studies. This typically involves searching multiple electronic databases (such as IEEE Xplore, ACM Digital Library, Scopus, etc.), as well as manual searching of key journals, conference proceedings, and other relevant sources. The search terms should be carefully chosen to encompass relevant concepts, such as "3D model," "GIS," "methodology," and related terms. Boolean operators (e.g., AND, OR) can be used to combine these terms effectively.

Inclusion/Exclusion Criteria: Define specific criteria for including or excluding studies based on relevance to the research question. In the context of the SLR on 3D modeling in GIS, inclusion criteria may include studies that focus on methodology development, case studies, comparisons of different approaches, and evaluations of 3D modeling techniques in GIS. Exclusion criteria may involve studies unrelated to 3D modeling or GIS, studies with insufficient detail on methodologies, or studies published in languages other than the review's primary language.

Study Selection: Screen the identified studies based on their titles, abstracts, and full texts (where necessary) to determine their eligibility for inclusion. Two or more reviewers should independently assess each study against the predefined inclusion/exclusion criteria to ensure reliability and minimize bias. In cases of disagreement, consensus can be reached through discussion or involvement of a third reviewer.

Data Extraction: Develop a standardized data extraction form to capture relevant information from the selected studies. This form may include details such as study objectives, research methods, software used, data sources, modeling techniques, and any findings or results related to the methodology of 3D modeling in GIS. Multiple reviewers can extract data independently to enhance accuracy.

Data Synthesis: Analyze the extracted data to identify commonalities, trends, and patterns across the selected studies. This can involve qualitative synthesis, quantitative analysis (such as meta-analysis, if applicable), or a combination of both. The synthesis should address the research question and provide insights into the methodologies used for creating 3D models in GIS. Visual aids, such as tables, figures, or diagrams, can be employed to enhance clarity and summarize the findings effectively.

Quality Assessment: Assess the quality and reliability of the included studies, considering factors such as research design, sample size, data sources, and potential biases. Quality assessment tools, such as the Newcastle-Ottawa Scale or the Risk of Bias Tool, can be used to evaluate the included studies' methodological rigor.

Reporting: Document the SLR process, including the search strategy, study selection process, data extraction methods, synthesis techniques, and quality assessment results. Prepare a comprehensive report that adheres to established guidelines for conducting systematic reviews (e.g., PRISMA guidelines) to ensure transparency and replicability. By following these steps, a systematic literature review can provide a thorough analysis of the methodologies used for creating 3D models in GIS, offering valuable insights for researchers, practitioners, and policymakers in the field.

5.1.1. ANALYSIS OF THE STUDY AREA

For the application of the present study, the city of Baghdad/run network in (Sadr City neighborhood in the city of Baghdad/RN) was selected, since it is experiencing a continuous and accelerated development, brought about by its characteristics of assistance center for the other neighboring cities, increasing even more its development perspective, without have well-structured urban planning.

The city of Baghdad is zoned into 29 neighborhoods. For this research, the Sadr City neighborhood was selected for modeling and subsequent analysis of its parameters. The choice was based on geographic criteria, since its location is close to the city center, thus presenting suitable characteristics for analysis in this study.

5.1.2. SOFTWARE

This phase involved choosing the software to be used in the development of the artifact. In this way, it was defined by the use of free and open-source software, in the map manipulation and georeferencing stage. This was chosen because it is free software, and because it allows exporting data compatible with the software used for 3D modeling.

For the modeling step, MATLAB was chosen, which is an urban modeling software from the company POLYSPACE This one stands out among the other options because it allows the creation of immersive and interactive urban environments, being able to import GIS software files to cut and import satellite images and 3D terrain, as well as footprint data from streets and buildings from OpenStreetMap.

In addition to allowing the export of finished 3D modeling to the web, together with ArcGIS online, where it is possible to publish Virtual Reality experiences, which can serve as a facilitating mechanism to access modeling and also to bring the community closer to planning.

5.1.3. STUDY OF PARAMETERS

In aiding urban management and control, especially when the intensification of land use and occupation is related to infrastructure capacity, the analysis of urban parameters of use and occupation of urban land is essential.

The urban parameters are also related to physical characteristics, such as geometric conformations, geometries of buildings [20]. Through its analysis it is possible to seek improvements in urban spaces.

The urban parameters generally present in the Master Plan instrument refer to the maximum height allowed for buildings, spacing and setbacks, built-up area, occupancy rate, utilization coefficient and permeability rate. With that, the parameters analyzed through the modeling of the neighborhood were: occupancy rate, and maximum number of floors, and built area. The criterion for choosing these parameters is that, in addition to being some of the most important parameters in the analysis of land use and occupation, they do not require modeling that is very rich in information and detail.

5.1.4. DEVELOPMENT GUIDELINES

In this step, the suggestion is operationalized and implemented, thus, the WEB-GIS integration guidelines were elaborated, presented in stages and tested in the application of the modeling of the Sadr City neighborhood in the city of Baghdad/ run network. Thus, making it possible to create the guidelines in a practical way, with proof of the efficiency of their application. In addition, perspectives were envisioned for replicating the guidelines in other case studies, with different investigation purposes, as well as the application of different parameters.

Step 4: Evaluation

At this stage, it was verified whether the proposed guidelines were efficient, by applying them in an experimental study and subsequently using the focus group technique, with the aim of measuring the performance of the artifact created in the DSR by the opinion of professionals in the area of architecture and engineering.

A. EXPERIMENTAL STUDY

1. Initial data processing

Initially, a selection and cleaning of the georeferenced data was carried out, which were provided by the Smart City Project, Research and Extension Center Access to Urbanized Land (2020). The Shapefiles contained data referring to some neighborhoods, blocks, lots and buildings in the city of Baghdad (Figure 4).

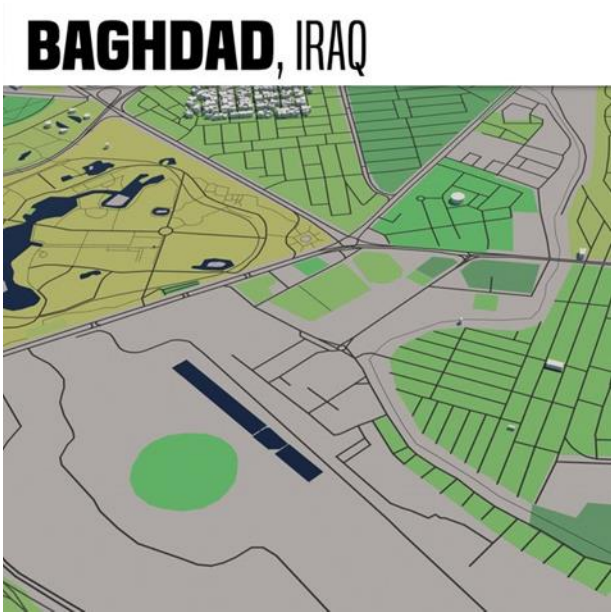

FIGURE 4: Shapefiles before selecting the study area

With that, in order to make a selection only of the data referring to the study area, the Sadr City neighborhood, some manipulations were performed on these files, excluding information referring to other neighborhoods that were contained in the same Shapefile, in the Qgis software.

2. Categorization of buildings

At this stage, the data were imported into the MATLAB software and synchronized with the map of the study area, Figure 5. Then, the categorization of buildings began, where each street in the neighborhood was checked, building by building, observing the number of floors each had.

FIGURE 5: Shapefiles after selecting the study area

At this point in the research, Google Earth and on-site visits between June and July 2022 were used to check the buildings. Simultaneously, in the MATLAB software, textures in white, yellow, orange and red were applied, referring to the number of floors of each building, as shown in Figure 6.

FIGURE 6: Shapefile integration with map

3. Elaboration of the algorithm

In the modeling software used (MATLAB) the generation of models can be done through code of rules or python script. Making it possible to create a three-dimensional model of cities, based on the existence of topographic data. Thus, due to the purpose of the research being directed to the parameterization and extraction of information from the modeling, the CGA module was used, which is a procedural methodology, in which the programming language called CGA (Computer Generated Architecture) is used, which allows that the rules and urban indicators are changed, thus giving freedom and space for new possibilities for projects and urban studies.

Rules created in CGA files are processed within the MATLAB environment. They are created programmatically in the development environment, and follow these steps:

The code of rules elaborated, according to the needs of the research, is presented in Figure 7, emphasizing that the question of the level of constructive detail of the buildings was not taken as a relevant point, in this research, that is, the issue of door openings, windows, design of roofs, among others. This can be a rule point added to the algorithm for future research.

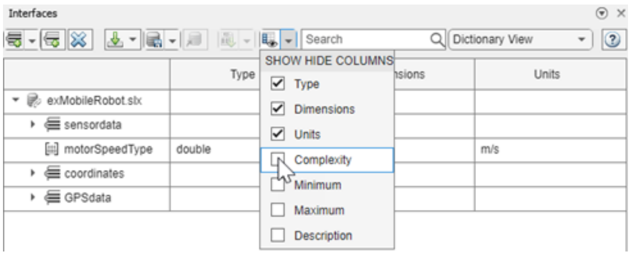

FIGURE 7: CGA editor interface

It was taken into account, especially when it relates to the intensification of land use and occupation and infrastructure capacity, the analysis of basic urban parameters due to the research initially addressing the implementation of rules in the algorithm. Thus, the main rules are related to the number of floors, height of the ceiling (height from floor to ceiling), template and built area and projection area of the building.

Step 5: Final considerations

This conclusion stage must synthesize what has been learned in all phases of the project, as well as justify the contribution of the work [20]. Thus, at this stage, the artifact was generalized to the class of research problems, pointing out the practical and theoretical contributions.

4. Steps and o details on tools and techniques are applied by using MATLAB in the following points:

1. Import GIS data: MATLAB supports reading GIS data formats such as shapefiles, GeoTIFFs, and LAS files using appropriate toolboxes like the Mapping Toolbox and Image Processing Toolbox. These toolboxes allow you to load the necessary spatial data into MATLAB.
2. Preprocess the data: Once the GIS data is imported, you may need to preprocess it to clean up noise, remove outliers, or perform other necessary operations. MATLAB provides a wide range of functions and image processing techniques that can be used for data preprocessing.
3. Perform spatial analysis: MATLAB offers spatial analysis functions that can be used to perform operations like point cloud processing, terrain analysis, surface interpolation, and spatial statistics. These functions help you extract meaningful information from the GIS data and perform calculations or measurements relevant to your 3D modeling algorithm.
4. Implement the modeling algorithm: Depending on the specific requirements of your 3D modeling algorithm, you can leverage MATLAB's extensive mathematical and computational capabilities to implement the necessary calculations and transformations. MATLAB supports matrix operations, numerical optimization, curve fitting, and other mathematical functions that can be used for modeling purposes.
5. Visualize the results: MATLAB provides powerful visualization capabilities that allow you to create 3D plots, surface plots, contour plots, and other visual representations of your GIS data and modeling results. You can customize the appearance of the visualizations and generate interactive graphics to gain insights into the 3D model.
6. Export the results: Once the 3D modeling algorithm is implemented and the results are obtained, MATLAB allows you to export the data or visualizations in various formats compatible with GIS software or other visualization tools.
7. It's worth mentioning that MATLAB's capabilities can be extended through third-party toolboxes or by integrating with other GIS software to enhance the functionality for specific GIS tasks.

6. RESULTS AND DISCUSSION

web-GIS integration guidelines: the integration between WEB and GIS is essential to transform information into knowledge and intelligence, positively impacting problem solving in sectors, both civil construction and infrastructure.

Studies dealing with WEB-GIS usually have two focuses, one on the GIS side and the other on the WEB side. On the GIS side, in seeking mapping technologies that use the facilities imposed by georeferencing to map study zones. Also, on the WEB side, the ability to integrate information into modeling (Figure 8).

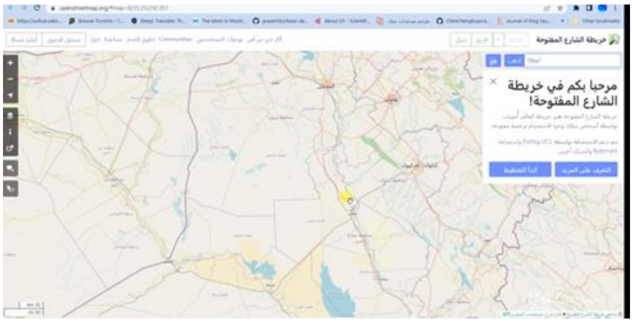

FIGURE 8: WEB-GIS integration guidelines

Data acquisition: The guidelines are initially based on obtaining georeferencing data for the area, prepared using GIS tools. Files in Shapefile format must go through a process of delimitation of the study area, in order to contain in the file only the georeferenced data of the blocks, lots and buildings of the neighborhood to which the modeling will be applied, this serves to facilitate the visualization of the region, as well as making the file less computationally heavy.

Initial processing of data: This step involves importing the Shapefile files into the MATLAB software, where they are synchronized with the spatial map of the studied region, in order to facilitate the visualization of the neighborhood.

With the synchronization already carried out, the analysis of the floor levels of each building in the neighborhood begins, a stage that includes both on-site visits and observation through the Google Earth software, making it possible to verify the floor levels of each building.

Subsequently, textures with different shades of yellow are applied, each shade referring to a number of floors, thus generating a mapping of the building's floor levels.

3D modeling: The first phase of this stage begins with the determination of the desired parameters in the final analysis of the modeling, that is, which information will be extracted automatically in the MATLAB software, thus defining the parameters of projection area, built area and building gauge. This definition is of paramount importance because it will impact the elaboration of the rules of the algorithm to be developed in the later stage.

The MATLAB software is based on the procedural modeling methodology, which is based on the creation of an algorithm with rules according to what you want to obtain as parameters in the final modeling. Thus, the development of the 3D modeling generation algorithm begins, containing the necessary rules for the automatic calculation of the aforementioned parameters.

Results obtained: From the application of the developed algorithm, within the MATLAB software platform itself, which happens with the initial selection of all Shapefiles referring to the buildings in the neighborhood and subsequent application of the algorithm, obtaining the automatic generation of the 3D modeling of all the buildings in the region.

After the generated modeling, the levels of the floors of the buildings are manually adjusted, as it was already predefined with the different textures, so that the algorithm can calculate their template. Thus, with the finished modeling, it is possible to automatically obtain the parameters: built area, projection area and gauge of the total height of the buildings.

Modeling presentation: With the 3D modeling finished, we sought to facilitate its visualization through Virtual Reality, so that to access it, it was not necessary to use software or even a computer. Thus, using one of MATLAB's differentials, which is the export of VR, through its Web Viewer extension that, together with ArcGIS online, publishes the modeling on a web page, which can be accessed by a smartphone, or any other device that has internet access, making the visualization and dissemination stage of this modeling more practical and easier, with access being possible through a web link.

6.1. FIRST VALIDATION

In the step after the elaboration of the guidelines, this method was applied in order to verify the applicability and functionality in a practical study, in the realization of the modeling of the Sadr City neighborhood in the city of Baghdad.

6.2. CATEGORIZATION OF BUILDINGS IN THE NEIGHBORHOOD

In the first stage of building categorization, the textures related to the floors were applied to each building in the neighborhood, even with the files in 2D format, as shown in Figure 9.

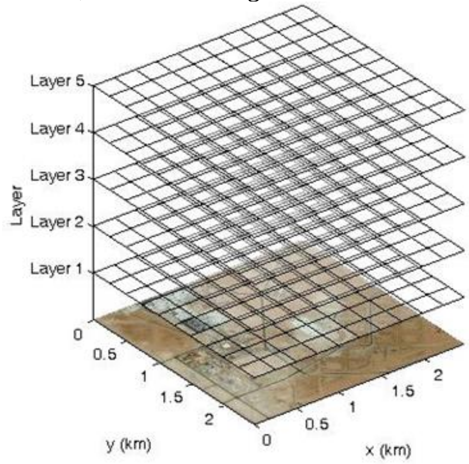

FIGURE 9 Categorization of buildings in the neighborhood

With this categorization of the neighborhood, it becomes possible to analyze in the color mapping how the verticalization of the neighborhood is developing. Another relevant point that can be observed is the increase in occupation by residential use in swampy land and subject to flooding, since some of the buildings are on the edge of the city's dam, as can be seen in Figure 10.

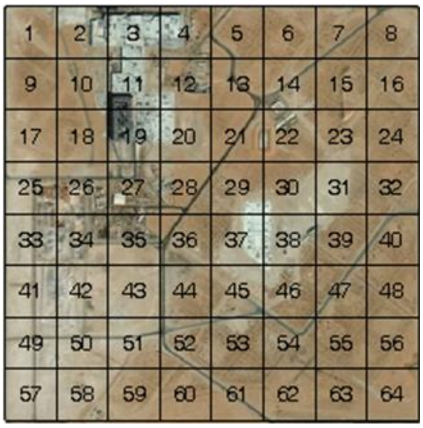

FIGURE 10 Areas close to the city

Given this analysis, it is possible to verify the need for planning and monitoring of cities, in order to guarantee security, adequate infrastructure and quality of life for the inhabitants. With the modeling of the city, it becomes better to visualize the distribution of land use and occupation, allowing decision-making aimed at security and better urban planning.

6.3 APPLICATION OF THE ALGORITHM

With the rules defined in the algorithm, the same was applied to the shape referring to the geometries of the buildings, thus generating a 3D model of each building in the neighborhood, according to the geometry of the georeferenced area of the shapefile. The algorithm also allows the user to add the number of floors manually, automatically updating the height of the building, as well as the right foot to be adopted as seen in table 1:

Table 1 Completed Systems Worksheet

Name	Description
Building	System to model the buildings and urban system.
Energy	System to model the generation, distribution, and consumption of energy.
Transportation	System to model the movement of people and cargo across several modes of transportation.
Waste	System to model the generation, distribution, and consumption of water.
Water	System to model the generation and processing of waste.

As a final product of the application of the algorithm, a 3D modeling of the neighborhood was obtained, with 1,496 buildings being modeled, generated in a few seconds after its application, which demonstrates the enormous effectiveness of the program in generating large-scale modeling, facilitating the step of modeling, which by other methods is something very time consuming and depends on powerful computers with a large processor. Modeling images can be seen in Figures 11 and 12.

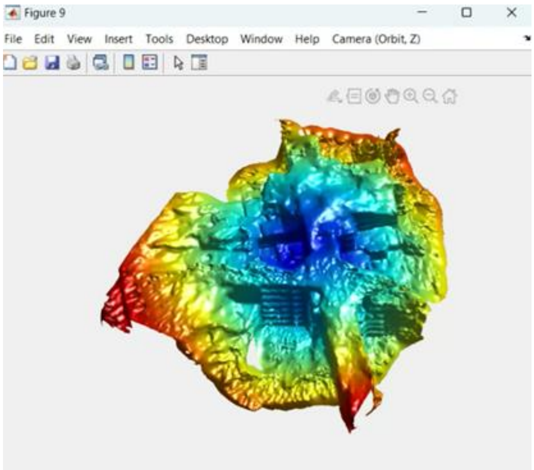

FIGURE 11 **Three-dimensional visualization of GIS data**

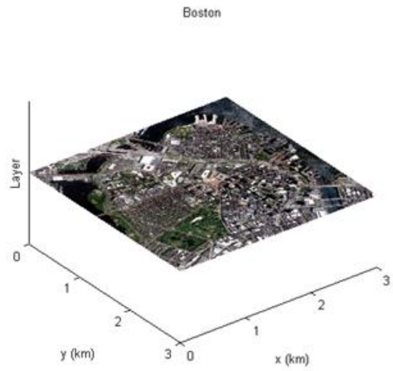

FIGURE 12 **Two-dimensional visualization of the neighborhood**

Through the mapping elaborated through modeling, it is possible to notice the form of spontaneous occupation and without planning, that is, the analysis favors the understanding of the urban space of the neighborhood and the visualization of its form. Another relevant aspect obtained with the modeling is the automatic extraction of information, such as the built area, projection area and template, as can be seen in Figure 13.

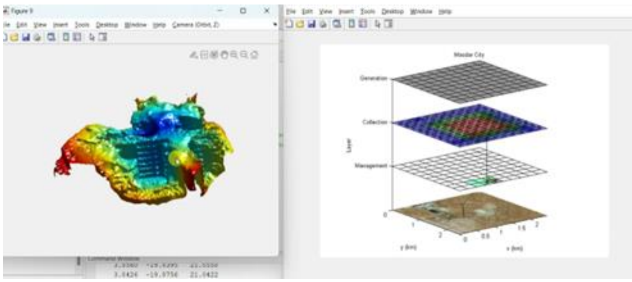

FIGURE 13 **Generated information**

With the results obtained, it is possible to highlight the main positive points that were made possible by the approach of the WEB-GIS methodology, making the modeling rich in information and saving relevant time (Figure 14). As well as identifying the possibility of adapting this methodology, to be applied in different situations, whether for the evaluation of urban indexes, compatibility checks with the master plan, among others.

Generating three-dimensional representations of urban environments is laborious due to the large amount of content that needs to be generated. This complexity makes it impossible to carry out large-scale urban modeling using tools that require individual attention and manual intervention for each of its elements, such as buildings, vegetation, among others.

In view of this, it can be noted that 3D modeling through the application of algorithms is a tool capable of facilitating this process, so that through it, it is possible to analyze and create simulations, in addition to the relevant fact of obtaining information in a way automatic, generating an impactful gain of time in the analyses. What is considered extremely necessary, since cities are in continuous transformation, generating a great level of complexity, either because of the new or because of the improvement of the existing one, growing, expanding the urban perimeter, occupying new areas and verticalizing those already built, transforming the use and occupation of the land.

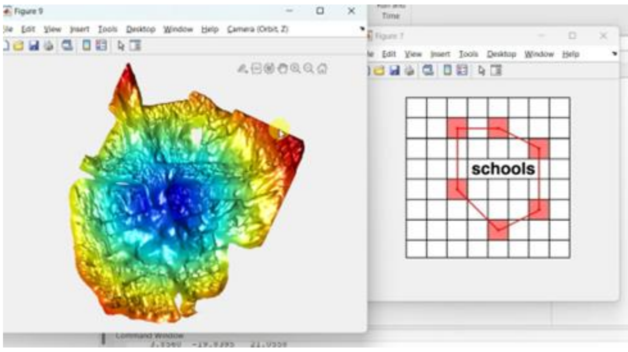

FIGURE 14 **Planning facilities in the WEB-GIS model**

6.1. Comparison with other studies

Comparing different studies on the 3D model visualization function for responsive web design can provide valuable insights into the strengths, weaknesses, and trends in this area. While I don't have access to specific studies conducted after my knowledge cutoff in September 2021, I can provide a general overview of the factors typically considered when comparing studies on this topic.

When comparing studies on 3D model visualization function for responsive web design, you can consider the following aspects of (Methodology, Implementation and Technologies, User Experience (UX), Performance, Compatibility, and Responsiveness as well as Novelty and Contributions)

Therefor, in the context of responsive web design, studies on 3D model visualization functions often focus on the following aspects:

1. Rendering Techniques [21]: Different studies may explore various rendering techniques for 3D models in a web environment. These techniques could include WebGL, CSS3D, or SVG-based approaches. Each technique has its own advantages and limitations in terms of performance, compatibility, and visual quality.
2. Performance Optimization [22]: Studies may investigate methods to optimize the performance of 3D model visualization on the web, especially for mobile devices. Techniques like level-of-detail (LOD) rendering, geometry simplification, or progressive loading can be explored to ensure smooth and efficient rendering across different devices and network conditions.
3. Interaction and User Experience [23]: The user experience is a critical aspect of 3D model visualization on the web. Studies may examine different interaction techniques, such as touch gestures or device motion controls, to enhance user engagement and immersion. Usability testing and user feedback can be incorporated to evaluate the effectiveness and intuitiveness of the implemented functions.
4. Responsive Design Strategies [24]: Responsive web design aims to provide an optimal viewing experience across a range of devices. Studies may explore responsive design strategies for 3D model visualization, such as adaptive layouts, flexible scaling, or dynamic content delivery. The goal is to ensure that the 3D models adapt seamlessly to different screen sizes and orientations.
5. Accessibility Considerations [25]: Accessibility is an important aspect of web design. Studies may discuss techniques to make 3D model visualization accessible to users with disabilities, such as providing alternative text descriptions, keyboard navigation, or compatibility with assistive technologies.
6. Cross-Browser and Cross-Platform Compatibility [26]: Ensuring compatibility across different web browsers and platforms is crucial for a consistent user experience. Studies may address the challenges and solutions for achieving cross-browser compatibility, including dealing with browser-specific issues and fallback mechanisms for unsupported features.

When comparing studies, it is important to analyze the methodologies used, the specific techniques implemented, the performance metrics evaluated, and the user feedback collected. This can help identify the strengths and weaknesses of different approaches and contribute to the overall understanding of the effectiveness of 3D model visualization functions for responsive web design [21-26].

7. CONCLUSIONS

The integration of WEB and GIS was the primary emphasis of this study, which was accomplished through the formulation of recommendations and the execution of a methodical procedure. It is possible to obtain, through its application, a set of solutions that are adaptable according to the need and desired priority in the modeling, taking into account parameters of gauge, constructed area, and projection area of the building. These solutions can be obtained in a manner that is compatible with the requirements of the modeling. This research was carried out so that an answer might be found to the issue, "How can we merge WEB and GIS?" The implementation of this technology proved that it makes the 3D elaboration stage may easier to achieve on a large scale. This was proved not just in terms of the amount of time spent, but also in terms of the amount of information that was collected through this modeling. may the most essential thing that was shown was that it is possible to make this 3D perspective available to urban planners or decision makers. This was may the most important item that it is possible to make this 3D perspective available to urban planners or decision makers. With the completion of the research, it is possible to identify a few noteworthy elements, which highlights the need to intensify the diffusion of the word CIM, which is research and studies that have the objective of delivering knowledge on this subject. This highlights the necessity to intensify the diffusion of the word CIM. In addition to this, the management of the urban planning sector does not make nearly enough use of the instruments that are at their disposal to simplify the process of integrating other industries. This causes the process of obtaining data to move at a more snail's pace, which in turn leads in missed opportunities to save both time and money. Finally, the goal of this study is to: According to the findings of the study, WEB-GIS is a system that is more adaptable and is able to deal with the complexity as well as the changes that characterize contemporary urban civilizations.

In the Future, work we focus on enhancing system features by incorporating various 3D model types, such as scalar as well as vector spaces or streamlines. It is significant to keep an eye on the quality use of WebGL technology because it may require system settings to be updated.

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CONFLICTS OF INTEREST

None

REFERENCES

[1] A. Dall'Asta, G. Leoni, A. Meschini, E. Petrucci, and A. Zona, "Integrated approach for seismic vulnerability analysis of historic massive defensive structures," *J. Cult. Herit.*, vol. 35, pp. 86–98, 2019.

[2] W. Felger, M. Frühauf, M. Göbel, R. Gnatz, and G. R. Hofmann, "Towards a Reference Model for Scientific Visualization Systems," Visualization in Scientific Computing, pp. 63–74, 1994, doi: 10.1007/978-3-642-77902-2_7.

[3] N. Freire, R. Voorburg, R. Cornelissen, S. de Valk, E. Meijers, and A. Isaac, "Aggregation of linked data in the cultural heritage domain: A case study in the Europeana network," *Information*, vol. 10, no. 8, p. 252, 2019.

[4] R. Billen et al., "3D City Models and urban information: Current issues and perspectives," 3D City Models and urban information: Current issues and perspectives – European COST Action TU0801, 2014, doi: 10.1051/tu0801/201400001.

[5] E. Moraitou, J. Aliprantis, Y. Christodoulou, A. Teneketzis, and G. Caridakis, "Semantic bridging of cultural heritage disciplines and tasks," *Heritage*, vol. 2, no. 1, pp. 611–630, 2019.

[6] P. Jensen, "Semantically enhanced 3D: a web-based platform for spatial integration of excavation documentation at Alken Enge, Denmark," *J. Field Archaeol.*, vol. 43, no. sup1, pp. S31–S44, 2018.

[7] F. Carraro, A. Marinello, D. Morabito, and J. Bonetto, "New Perspectives on the Sanctuary of Aesculapius in Nora (Sardinia): From Photogrammetry to Visualizing and Querying Tools," *Open Archaeol.*, vol. 5, no. 1, pp. 263–273, 2019.

[8] M. Reddy, Y. Leclerc, L. Iverson, and N. Bletter, "TerraVision II: Visualizing massive terrain databases in VRML," *IEEE Comput. Graph. Appl.*, vol. 19, no. 2, pp. 30–38, 1999.

[9] "Three.js." https://threejs.org/ (accessed Oct. 17, 2017).

[10] "Babylon.js," *Babylon.js*. https://www.babylonjs.com (accessed Oct. 17, 2017).

[11] "Scene.js." http://daybrush.com/scenejs (accessed Oct. 17, 2017).

[12] M. Schütz, "Potree: Rendering large point clouds in web browsers," *Tech. Univ. Wien Wiedeń*, 2016.

[13] M. Potenziani, M. Callieri, M. Dellepiane, M. Corsini, F. Ponchio, and R. Scopigno, "3DHOP: 3D heritage online presenter," *Comput. Graph.*, vol. 52, pp. 129–141, 2015.

[14] J. Behr, P. Eschler, Y. Jung, and M. Zöllner, "X3DOM: a DOM-based HTML5/X3D integration model," in *Proceedings of the 14th international conference on 3D web technology*, 2009, pp. 127–135.

[15] M. Potenziani, M. Callieri, M. Dellepiane, and R. Scopigno, "Publishing and consuming 3D content on the web: A survey," *Found. Trends® Comput. Graph. Vis.*, vol. 10, no. 4, pp. 244–333, 2018.

[16] F. Mwalongo, M. Krone, G. Reina, and T. Ertl, "State-of-the-Art Report in Web-based Visualization," in *Computer graphics forum*, Wiley Online Library, 2016, pp. 553–575.

[17] A. Evans, M. Romeo, A. Bahrehmand, J. Agenjo, and J. Blat, "3D graphics on the web: A survey," *Comput. Graph.*, vol. 41, pp. 43–61, 2014.
[18] R. Scopigno, M. Callieri, M. Dellepiane, F. Ponchio, and M. Potenziani, "Delivering and using 3D models on the web: are we ready?," *Virtual Archaeol. Rev.*, vol. 8, no. 17, pp. 1–9, 2017.
[19] M. Barrettara, "New methods for sharing and exhibiting 3D archaeology," *The Posthole*, vol. 31, no. 2013, pp. 8–13, 2013.
[20] N. Statham, "Scientific rigour of online platforms for 3D visualization of heritage," *Virtual Archaeol. Rev.*, vol. 10, no. 20, pp. 1–16, 2019.
[21] L. Franke and D. Haehn, "Modern Scientific Visualizations on the Web," Informatics, vol. 7, no. 4, p. 37, Sep. 2020, doi: 10.3390/informatics7040037.
[22] E. Touloupaki and T. Theodosiou, "Performance Simulation Integrated in Parametric 3D Modeling as a Method for Early Stage Design Optimization—A Review," Energies, vol. 10, no. 5, p. 637, May 2017, doi: 10.3390/en10050637.
[23] H. Kharoub, M. Lataifeh, and N. Ahmed, "3D User Interface Design and Usability for Immersive VR," Applied Sciences, vol. 9, no. 22, p. 4861, Nov. 2019, doi: 10.3390/app9224861.
[24] R. Castelo-Branco, A. Leitão, and G. Santos, "Immersive Algorithmic Design Live Coding in Virtual Reality," Blucher Design Proceedings, Dec. 2019, doi: 10.5151/proceedings-ecaadesigradi2019_179.
[25] J. H. Lee, Y. M. Kim, I. Rhiu, and M. H. Yun, "A Persona-Based Approach for Identifying Accessibility Issues in Elderly and Disabled Users' Interaction with Home Appliances," Applied Sciences, vol. 11, no. 1, p. 368, Jan. 2021, doi: 10.3390/app11010368.
[26] S. Liu, Y. Feng, X. Wang, and P. Yan, "Cross-Platform Drilling 3D Visualization System Based on WebGL," Mathematical Problems in Engineering, vol. 2021, pp. 1–18, May 2021, doi: 10.1155/2021/5516278.