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3D Scene Augmentation for Floor Planning

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***Abstract*—Using 3D virtual environments in floor planning offers major improvements over traditional 2D blueprints. By transitioning from traditional 2D blueprints to detailed 3D models, designers and architects can gain a more comprehensive and interactive understanding of spatial arrangements. The process involves turning 2D plans into 3D models through data collection, modeling, and rendering. Challenges related to software integration, data management, and user interface design are discussed, with strategies for overcoming these issues. AR then allows users to explore these models in a realistic, interactive way before any physical construction begins. This makes it easier to collaborate and make decisions based on a clear view of how the design will work in real life. This approach helps people see and adjust designs before they are physically built, making the planning process more accurate and collaborative.**

Keywords—Machine Learning, Augmented Reality, Floor plan, Edge detection, Computer Vision

I. Introduction

Two-dimensional blueprints have long been used in the floor planning industry to represent spatial designs. Even though 2D drawings have been crucial to the fields of architecture and interior design, they usually fall short of capturing the intricate detail of a given space. The use of three-dimensional (3D) scene virtualization is changing how spaces are perceived, created, and experienced because of technological advancements.

By creating detailed three-dimensional models of environments, 3D scene virtualization allows designers and architects to work with their designs more accurately and immersive than they could with only 2D sketches. Experts can produce realistic representations of floor plans using advanced modeling software and augmented reality (AR) technologies, which improves understanding of spatial relationships and design elements.

This approach improves decision-making and design accuracy in addition to visual clarity. Users can virtually navigate and examine spaces, assess the impact of different design choices, and make instantaneous changes. This interactive procedure enhances teamwork and offers a more intuitive and engaging method to present and improve design ideas, fostering better collaboration within the team.

The use of 3D modeling for floor plans is a relatively new method that has grown in popularity recently. Photogrammetry, laser scanning, computer-aided design (CAD), and other methods are some of the methods used in 3D modeling. Even though CAD software is frequently used to create 3D models of buildings, the process can take three to four days. Another method that calls for high- quality images is Photogrammetry. Although it can be costly, laser scanning is also effective. On the other hand, the suggested system offers more features like zoom-in and zoom-out along with quicker results. Additionally, no prior knowledge of CAD software is necessary to operate the suggested system, which is simple to use.

II. Literature Survey

[1] The Virtual Experience Toolkit (VET) uses computer vision and deep learning to quickly and accurately create 3D models from real indoor environments. This automated process improves the efficiency and precision of 3D visualization, enhancing VR applications. They integrated a single application to automate virtualization of 3D objects using deep learning methods. It can handle indoor objects and can work with around 200 classes. This framework was used to analyze scenes from the ScanNet dataset and some custom indoor scenes. This approach is set to be used for mental treatment by creating a safe virtual environment created using VET. The user will experience new realities without phobic situations. The VET can be highly scaled and is an automatic framework.

[2] The combination of virtual reality (VR) and 3D animation has revolutionized effects in the media industry, resulting in more expressive and captivating work. VR adds realism to user experience by integrating physical elements and character interactions. Motion capture and 3D or aerial photos enable real-time physical interaction with 3D models. However, advanced workflows and data loads are issues. But, innovations in visual media do offer new levels of realism and creativity that were never experienced before. They gave a new 3D technology method for designing animation scenes that is faster than the binocular vision method for point cloud computation. By using a grid node for depth information, the new method significantly reduces computation time. For example, at 12 experiments, it takes 48.97 minutes compared to 128.97 minutes for the binocular vision method.

[3] This study aims to explore the use of deep learning and 3D visualized scenes in wireless identifying anomalies in a sensor image. Techniques for detecting and classifying anomalies are centered on a number of issues, such as equipment malfunctions, signal interference, and an overall amount of pattern data. CNN-based deep learning algorithms are ideal for these kinds of anomaly identification methods. One only needs to produce a collection of training images that can be used as an adequate representation of common phenomena in order to correctly identify instances of a 3D visualized complex scene that also contain abnormalities. Because it enables a much more dependable system by reacting in real time to damage or interference patterns, this application is very helpful when analyzing sensor data on a larger scale. Furthermore, it facilitates a clearer understanding of how sensor anomalies function, leading to a more positive method of operating and evaluating sensor systems. In conclusion, the techniques enable the creation of a thorough strategy for tracking sensor network performance and identifying issues, expanding the range of their uses and dependability.

[4] The purpose of this study is to learn how to use three-dimensional modeling technology to create virtual environments for interactive teaching. In addition, the data-driven approach is used to model the equipment's dynamic states, and VRML enables user-equipment interaction in a virtual environment.Additionally, the inclusion of multi-role interaction technology in the virtual environment promotes collaboration between students and teachers as well as between students. Students' practical skills, teamwork abilities, and participation in the learning activities are all developed through this kind of active and participatory learning. Additionally, the virtual operation environment increases learners' motivation in addition to improving training outcomes. It discusses using 3D virtual reality technology to create training environments for electrical equipment in higher education. Using 3ds Max, virtual components are statically modeled, rendered to match standard experimental equipment, and then exported. This approach facilitates comprehensive sensory simulations and realistic training scenarios.

[5] The authors of this paper discuss a surface transformer-based, one-stage 3D object detection method that incorporates a transformer 3D encoder and a new local umbrella surface description. Finely detailed local features are captured by the local umbrella surface description, which encodes first order gradient slices of each object point as feature vectors. In order to better describe the object, the transformer 3D encoder combines local surface features with global long-term features extracted from the input point cloud. The network can focus on the central regions of the point cloud scenes by using an instance- aware down sampling technique. The results show that this technique outperforms the other one-stage detectors among the current methods.

[6] Using image processing and augmented reality (AR), this paper presents a novel approach to reconstructing three-dimensional models from two-dimensional floor plans. Computer vision algorithms are used to determine the arrangement and measurements of a 2D paper plan that was taken with a smartphone camera. Interactive 3D representations of the 2D models are produced using AR tools, allowing for dynamic exploration. Tested on real building floor plans, the approach produced accurate and efficient results. This development provides a new generation of augmented reality tools that help designers or architects collaborate and communicate more effectively. The improved visualization of the designs helps clients comprehend them more clearly.

[7] In this paper, the authors attempt to show how virtual environments can be used in training as well as in the maintenance and repair of manufacturing facilities and industrial plants. The authors describe a software framework designed to improve industrial system assembly, operation, and maintenance tasks in the context of 3D modeling, animation, and simulation. Because the platform provides trainees with realistic and interactive experiences, it lowers training costs and increases training efficiency. By simulating their operation in an interactive setting, it also aids in the maintenance of industrial installations. Two applications illustrate the framework's adaptability and show how it can enhance industrial procedures. Additionally, this represents a significant advancement in the application of virtual environments for industrial maintenance and training. The system's performance improvement during real-world applications is encouraging because it points to a wide range of potential uses for this technology.

[8] Although the Virtual Repository is still under development, this paper outlines its development with the goal of serving as a research and teaching tool for museum collection access. The repository improves the research and education outreach of distant researchers, students, and the general public by filling in the gaps in remote access. For many decades, it builds a permanent online library of artifacts, fossils, locations, and information for use in research and education. The goal is to produce researchers who are focused on museums and conduct analyses that were previously impossible. Additionally, the repository offers researchers, educators, and students new ways to engage with virtual collections, which has the potential to change how science is conducted and taught. It addresses the challenges researchers face with data aggregation in various scientific fields, particularly in natural history and archaeology. It points out that limited access to collections has led to issues with data comparability and reliance on published conclusions. To overcome these challenges, it advocates for the creation of virtual repositories using advanced 3D technologies and image-based database systems. These virtual collections, accessible online, can significantly enhance scientific analysis and make collections available to researchers, students, educators, and the public globally.

[9] This study introduces an improved image matching method that addresses the registration of three-dimensional CT and two-dimensional x-ray images. It is important to register these images so that the area of interest is precisely maintained within the radiation zone when the patient is exposed to radiation. The authors examine the application of various matching criteria to attain proper image registration and observe that partial volume interpolation- based mutual information (MI) appears to be the most effective. Three search strategies have been tested for this purpose, and the best one for in-plane refined search is a modified Powell method. The average mean square error for translation and rotation using the suggested algorithm is as low as 0.26 mm and 0.38 degrees, respectively, according to qualitative and quantitative analysis of the results obtained. The simulations validate the suggested approach, which asserts that it is clinically viable. The correspondence problem solution in medicine is improved by this study.

[10] This work focuses on low-cost methods of producing and viewing 3D objects by developing a novel architecture for 3D acquisition, transmission, and display. It is cloud-based and provides explanations for all 3D tasks, making it an extensible and user-friendly interface. In order to increase the depth of 3D materials, the system has a crucial 2D to 3D video conversion technology that is supplied both in the synthesis stage and in the real-time processor. Image-based rendering techniques with replication structure are used to enable thin penetrability and guarantee the efficient and high-quality representation of 3D content. When anti-aliasing pixel rendering is used, the quality of the 3D presentation is improved. By using integrated 2D/3D windows (i2/3DW) with a micro retarder, the user can interact with the 3D environment by viewing both 2D and 3D images on the same screen. Such a localized 2D/3D display can be used in web services, 3D TVs, movies, and games. The paper also lists a few 3D image formats that may be utilized in the future for 3D technologies. Generally speaking, this strategy should

make it easier to create an operational breakthrough that will enable the deployment of more sophisticated 3D algorithms for wider applications.

III. EXISTING SYSTEMS

AR platforms like Microsoft HoloLens, Apple ARKit, and Google ARCore are laying the foundation for 3D space. To capture the spatial context, these systems integrate sensor fusion and computer vision. They can place 3D virtual simulations in real life for viewers to view and interact with, increasing immersion, by comprehending the surfaces, lights, and motions of objects. These platforms can be used in a wide range of fields, including gaming, retail, education, and even industrial design. For instance, ARKit makes use of SLAM technology and depth information to enable extremely accurate 3D object placement. In order to improve body-less movement, Earth also recognizes motion tracking and comprehends the environment. These platforms may, however, require supporting hardware for improved processing power which may be difficult for low- end devices.

Marker-based systems use physical markers, like tags, QR codes, or other preset patterns, to position the 3D content in a scene. These markers were used in the development of platforms like Vuforia and ARToolkit, which allow users to precisely position virtual objects in the real world. In order to attach the augmentation to a marker, the system ascertains the marker's position, orientation, and scale after a camera takes a picture of it. This method works well in controlled environments like museums, product displays, or AR-based training. Its dependability and low processing requirements, which enable it to function on outdated devices, are its most valuable features. Quite the opposite, the use of such markers does not allow the flexibility since an augmentation can only be done in a predetermined place where the marker ID can be seen.

Marker-less AR uses sophisticated features like SLAM to recognize and create surfaces and other features in space because it lacks physical markers. The two most popular tools in this field are ARCore and ARKit, which enable the addition of depth, textures, and geometry to any space. These systems are appropriate for applications such as navigation, virtual interior design, and augmented reality games like Pokemon GO. Working with marker-less AR has the advantage of being more adaptable than marker- based techniques and operating in more unpredictable and dynamic environments. However, such AR necessitates complex hardware and suffers from poor tracking accuracy in feature-poor environments (plain walls or low light).

3D models of actual locations can be created and reconstructed with the use of technologies like Li-DAR and photogrammetry. In order to create accurate representations of real space, including virtual objects, these systems collect and integrate texture and depth data. Apple devices can now precisely record the depth of their surroundings in real time thanks to Li-DAR integration, which enables occlusions and more lifelike interactions with other virtual objects in augmented reality. Overlapping images then produce a photogrammetry model, which is used extensively in computer games, anthropology, and even urban planning. These technologies are demanding in computation and for larger space modeling, but they guarantee a very high degree of realism and accuracy.

Augmented interactive 3D holograms are used by Microsoft HoloLens, Magic Leap, and other comparable devices to interact with real-world applications. These holographic systems use spatial mapping and gesture recognition to enable smooth user interaction with augmented elements. Joint modeling, medical training, and military training are a few possible uses. For example, engineers can view 3D models of machine designs, and medical students can use virtual structures to learn about the anatomy of the human body. Although holographic enhancement offers the highest level of immersion and customization, it is too costly for average users and necessitates precise calibration to maintain the necessary spatial relationship as well.

By projecting three-dimensional images onto asymmetrical shapes like buildings, sculptures, or objects, these projection systems enhance the visual appeal of the physical world. Moving images produced by technologies like 3D projection mapping are frequently used in advertising, show business, and architectural visualization because they are not static with respect to the mapped surfaces. Motion, texture, and artificial lighting are all animated and visualized by them. For instance, projection mapping transforms event landmarks into a storytelling tool. Though some one-time setups, calibrations, and special equipment are required, this method is undoubtedly sufficient for dramatic presentations; however, it detracts from the realism of everyday or small-scale use approaches.

In the meta verse, Meta Quest Pro and Spatial are more than just cooperative systems. Regardless of user distance, these virtual systems allow users to interact with augmented 3D scenes in real-time. Cloud computing is necessary for these systems to perform a number of tasks, including alignment and spatial coordination. These features include virtual meetings, remote assist training, and collaborative design, among others. For example, students may work in groups on AR projects, and architects may work together on building designs. This tool is very useful for teamwork, but it has drawbacks as well. It needs a powerful internet connection and sophisticated equipment, which makes it challenging to use in places with limited bandwidth or on devices with less sophisticated features.

Engines like Unreal Engine and Unity are industry standards for producing augmentation scenes. These engines employ cutting-edge rendering technologies, which drive the application of realistic lighting and physics to produce augmented environments of the right caliber. Developers can create applications that are tailored for various mobile devices and AR headsets by integrating AR/MR plugins like Vuforia and AR Foundation into the application. However, game engines are not just used for gaming; they are also used for AR education and industrial simulations. However, smaller teams or individuals may find it difficult to afford the knowledge and resources needed to create augmented scenes.

Augmented elements have been added by Oculus Quest and HTC Vive, allowing users to work with virtual content while simultaneously being aware of their physical surroundings. With VR devices, for example, users can use real objects, like chairs and other gadgets, in a simulating environment by using displacement cameras. In industries like entertainment, prototyping, and training, this is frequently done. It is true that VR systems with pass- through cameras offer a great deal of immersion, but they are typically more expensive and have a steep learning curve for both the developer and the user to get the most for the devices.

IV. Proposed System

The advances in technology has given rise to fresh viewpoints in the domains of interior design, real estate, and application architecture. It takes a long time and requires a high level of technical expertise to convert 2D plans into 3D models using the traditional method. Furthermore, there is still a problem with showing these models in real time in AR. To address these issues, we present a Django application in this paper that automates the process of converting 2D floor plans into 3D models. It creates GLTF models that are appropriate for augmented reality and that are easily viewed in the environment or as simple 3D models by combining edge detection, vectorization, and Blender scripting.

The proposed system combines various image processing processes with 3D modeling and augmented reality visualization to provide a straightforward operating environment for the architect, designer, and end users. As shown in Figure 2, e-commerce users can upload a 2D floor plan because the web interface is easy to use. To create the outlines of the fundamental structural components, such as walls, doors, and windows, the uploaded image is put through preprocessing steps like edges detection and vectorization. These vectors are then processed by a Blender headless script to create a 3D model in GLTF format. After that, the client receives the model back with features that allow for 3D or augmented reality interaction.

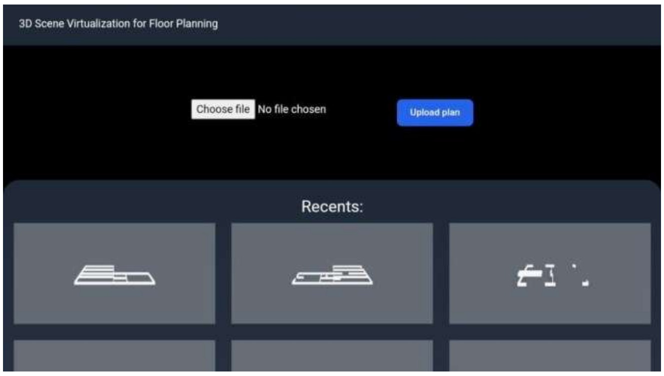

Fig. 1. UI for uploading floorplans

The vector data is processed by a custom Blender script that is running in headless mode on the server. Headless operation improves efficiency and enables remote execution by executing depth 3D model development without a graphical user interface. After parsing the geometric data, this script creates a three-dimensional shape. The structures are given height and dimensions using this script so that the model somewhat resembles the original floor plan. The end product is a GLTF file format that facilitates AR visualization across a wide range of platforms and is simpler to transfer.

The system begins as a Django web application that allows users to submit 2D floor plans in different image formats. The image undergoes a compatibility and quality check upon upload. Before the edges are identified, the original image goes through a phase where noise reduction and binarization are applied to improve image clarity. Since edges have a significant impact on the final product, it is also possible to argue that accurate 3D reconstruction cannot be produced without the right edges.

The image undergoes edge detection using Canny edge detection techniques following preprocessing. This technique identifies the edges and contours of the floor design plans. The chosen edges are then converted into vector data so that the design can be altered more easily. The scaled layout images must be vectorized in order to improve the retrieval of geometric information, which is why it is necessary as an input for the creation of a 3D model.

However, one of the system's main challenges continues to be the effective detection of edges for complex or low-quality floor plans. During the edge detection phase, adaptive threshold and robust preprocessing techniques are employed to increase efficacy. The automatic use of Django in Blender's 3D model generation process is also pertinent. This enables the system to operate remotely, which is crucial for the server implementation of the application, and eliminates the graphical overhead that slows down the process. Optimized scripts are used to prepare Blender models for rendering, improving both rendering speed and model quality.

The proposed system is widely applicable in fields such as architecture, interior design, and real estate. For instance, architects can use it to rapidly create 3D models from blueprints, while real estate brokers can use interactive augmented reality to help prospective buyers see the property. Furthermore, by allowing users without technical expertise to utilize it, the system can expand the application of 3D modeling. AR integration also helps users become more interested in and understand spatial structures, which helps translate a design from a two-dimensional plan into practical settings.

V. System Architecture

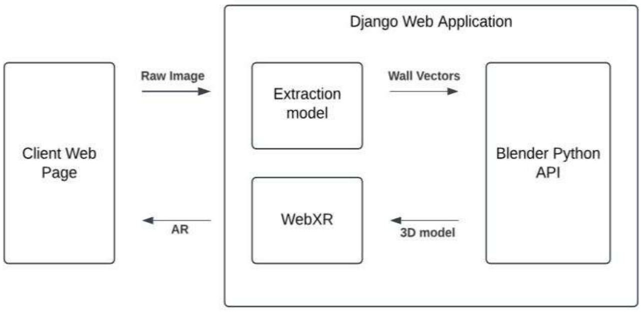

Fig. 2. Higher level Architecture diagram

VI. Methodology

By creating fully interactive 3D models from two-dimensional floor plan images, the "3D Scene Augmentation for Floor Planning" project seeks to give users an augmented reality experience. The process involves a number of steps, including image uploading, image preprocessing, edge extraction, 3D model synthesis, and embedding AR tools. All of these stages serve as the foundation for giving users a striking and captivating environment that is integrated with 3D and AR floor plans. The following subsections of the methodology elaborates on how each of the components works.

The first step involves the user uploading a 2D floor plan image using a Django framework-based web application. The compatibility of the various image file formats in which the floor plan images can be uploaded is verified. A preprocessing step is applied to the image in order to enhance its quality before more complex operations are carried out on it. The image above is subjected to noise filtering, edge sharpening, and conversion to greyscale. The image is primed for edge detection and vectorization through this preprocessing, which also creates the ideal environment for accurate 3D model generation and rendering.

The primary objective of this project is identifying the floor plan's edges. Walls, windows, and doors are among the structural elements that are identified using the Canny edge detection algorithm. The next step after detecting edges is vectorization, which transforms the pixel-based edges into geometric shapes like curves, straight lines, etc. for use in 3D modeling. This stage guarantees that the 2D floor plan and vector graphics for 3D rendering are included in the clear and expandable structural information.

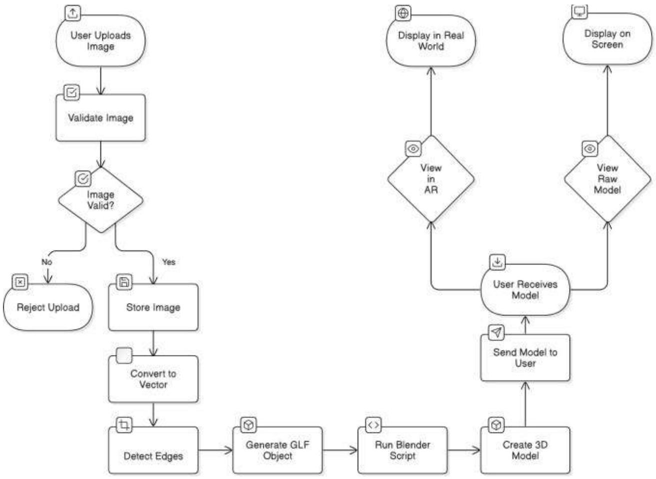

Fig. 3. Flowchart

The next stage involves taking the 3D models of the rooms after vector defining them, which is accomplished by running Blender in headless mode on the server. Blender's robust 3D rendering capabilities are used to create a 3D model from the vectorized image of the floor plan. The Blender script, which interprets vector data, controls an automated process that extrudes the walls, adds height to the structures, and constructs objects (in this case, doors and windows) in three dimensions. This method works faster and produces models more efficiently on a server because it doesn't require human input and doesn't use a graphical user interface. Optimization techniques are used to make the generated 3D model as efficient as possible in AR and to make it easy to load on a variety of devices. This means that in order to improve rendering speed without compromising visual quality, the model's polygon count and complex geometry must be reduced. The user can safely access and retrieve the 3D model after it has been optimized and uploaded to cloud-based systems. Because a large number of users can utilize the model without causing the system's performance to deteriorate, this approach ensures scalability. The result is a GLTF file, which is a lightweight, interactive three-dimensional file.

Once a 3D model has been created and stored in the database, AR can be used to access the model's functionality directly. By using WebXR API or other AR-enabling frameworks, AR can be utilized on smartphones or AR goggles. It gives users an immersive experience by enabling them to view the two-dimensional floor plan as a three-dimensional, movable object. To provide a clear image of the layout and dimensions of the floor plan, users can manipulate the model using augmented reality (AR) by rotating it in real time, zooming in and out, and scaling it.

The system provides two modes of interaction once the 3D model is finished. The viewer has the option to view the 3D model in augmented reality on their mobile device or download it in the GLTF format and view it in other 3D modeling programs. Specialists like architects and designers, as well as clients who wish to view the object arrangement in augmented reality or through a 3D model viewer, require this multitasking approach. Both personal and professional applications can enhance 3D scenes thanks to the interactive features.

Blender operates in headless mode to create the 3D models at the server level. Any plan that a user uploads to the server causes Blender scripts to run automatically on the server side. Backend functionality is provided by Django. It is in charge of all incoming requests that are sent to the Blender instance by the user. The user doesn't have to wait for the model to be processed and finished on a personal computer because Django and Blender work together to complete all the processes. Because fewer processing engines are used in this method, the overall cost of the approach is also decreased.

The user-friendly application uses new technologies to convert 2D floor plans into formats that allow for the creation of intricate 3D models. It makes use of Blender headless 3D modeling, augmented reality, and sophisticated system image processing techniques for edge detection to create an engaging and successful user experience. It is an entirely automated process that is capable, adaptable, and made for situations like communicating with clients and rendering building designs. The method ensures that the process is rendered quickly as a result of high-quality model generation while still allowing users to interact with the 3D design or 3D asinine, making it useful in many modern design processes. Refer to Figure 3 for a simplified flowchart on the working of the proposed model.

VII. Result and Analysis

The project's goals included improving the current models to operate better and reconstructing them in three dimensions from two-dimensional floor plans using unprocessed photos. The 3D models created were expected to improve the system's overall performance. In addition, the program offered 3D modeling for use in virtual or augmented reality settings.

The system's vectorization procedures and cutting-edge Canny edge detection algorithm both demonstrated a consistently high success rate in defining the floor plan's outer edges. Despite some layering, it was still possible to outline windows, doors, and walls in the floor plans. The system was reasonably successful in preprocessing the floor plan to get it ready for rendering a 3D model, though there were still problems with very dense or low quality imagery. Figure 4 shows an example of converting flow plan images to 3d model.

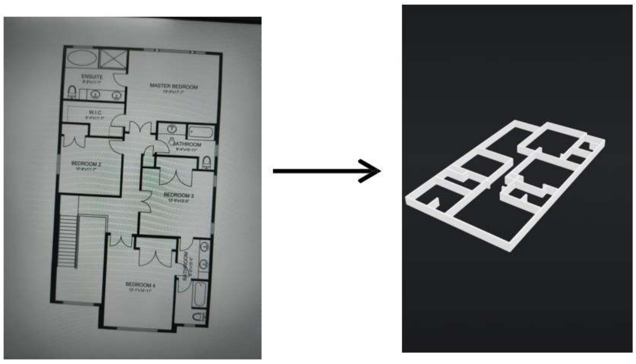

Fig. 4. 2D floorplan to 3D model

When using Blender in headless mode to convert the 2D architectural floor plans to 3D models, satisfactory results were obtained. With precisely extruded elements and meshed walls, the graphical models produced from vectorized data are true to the original. Because it allowed for integration with the viewers of both 3D models, the model's conversion into the GLTF format was suitable for this use. The capabilities of augmented reality integrated with the WebXR API were tested on a variety of devices. Because users could view and interact with the 3D model in real time, the augmented reality experience was consistent. Along with the inclusion of suitable scaling, rotating, and zooming features, the requirement to interact with the model in a real-world communal setting was also given. Additionally, because the system was compatible with mobile devices and consistently maintained a steady frame rate, users were able to fully visualize floor plans within their surroundings.

As shown in Figure 5, the 3d model was successfully augmented on to a coffee table. The overall performance of the system was evaluated using the total time required to complete the tasks as well as the number of resources used for each task. Depending on how complex the floor plans were, it took less than a few minutes to create 3D models on the server side using blender scripts. Users' concerns about scalability and access speed were addressed with the help of the strategy of saving and retrieving models via cloud storage. The speed of model generation and the quality of AR interactions were not significantly impacted by changes in load or the number of concurrent active users.

Fig. 5. 3D floor plan Augmentation

Architects, designers, and end users who tested the "3D Scene Augmentation for Floor Planning" system during its trial period gave very positive feedback, praising the system's usability and AR features, the accuracy of the 3D models, and the user-friendly interface. Customers in particular wanted to be able to view and work with the floor plans in 3D and AR formats because it made it easier for them to visualize the spaces. The users, however, requested additional features, such as the ability to instantly alter 3D objects and modify the features of multi-story buildings.

The system undoubtedly produced excellent results, but there was still opportunity for some enhancements. It was observed that the edge detection method occasionally suffered from more intricate floor plans or edges that were difficult to see, leading to small errors. The accuracy of edge detection and the general capacity to vectorize intricate 2D outlines into 3-dimensional models should both be enhanced by utilizing machine learning algorithms for automated pattern analyses. Additionally, adding augmented reality features like virtual tours or more tools for user customization would greatly enhance the user experience. All things considered, the system performed edge detection, modeling, and AR interface tasks efficiently, laying solid groundwork for future advancements in 3D scene augmentation technology and virtual design applications.

VIII. CONCLUSION

The "3D Scene Augmentation for Floor Planning" project successfully uses modern methods to turn 2D floor plans into captivating three-dimensional models. Through the use of Blender for 3D model creation, image processing with edge detection, and real-time interaction with the physical world through AR technologies, the framework facilitates interaction of floor plans in headless and augmented reality formats. By simplifying spatial layouts and facilitating interaction with them, the integration of these technologies enhances understanding of design theory and provides an impressive array of functionalities in architectural visualization and representation.

Despite the success, there is still room for improvement. When dealing with intricately designed floor plans or poorly defined borders, the edge detection technique is limited, which results in minor errors. The use of machine learning (ML) for more sophisticated edge detection and vectorization methods on more intricate floor plans can help to mitigate this drawback. In addition, there should be more options for AR features, like walkthroughs and real-time editing for virtual tours. Overall, this project opens up possibilities for 3D scene augmentation, including altering the way floor plans are viewed and the architectural planning and execution design process.

IX. FUTURE WORK

A variety of modifications can significantly improve the system's functionality, accuracy, and user experience. First, the edge detection and vectorization step needs to be improved. As is, it is anticipated that the system will have errors in interpreting complicated or imprecise floor plans and geometry, leading to a relatively lower level of precision. The system might be strengthened by incorporating machine learning algorithms or deep learning models for edge and boundary detection, especially when working with intricate or distinctive building designs that demand a higher level of accuracy.

AR support is another goal that will be added in the future to address the system's current limitations. Although the system currently allows the user to place three- dimensional models in augmented reality, more advanced features like 3D visual tours, real-time user editing, or 3D models with multiple users would be advantageous. Additionally, enabling users to view various floor levels in augmented reality would be a useful addition to multi-story buildings. This would be advantageous for more experienced architects and designers working on more intricate projects.

Future directions for the project will include the integration of cloud storage and synchronous communication tools, allowing multiple users to collaborate on a floor plan while editing a 3D model or plans. The idea for additional actions would also be to increase the possibilities of AR, incorporate real-time changes, and make the system more adaptable. Additional enhancements would increase the system's efficacy as a spatial visualization tool by, among other things, streamlining the floor plan upload process, enhancing the user interface (UI) and user experience (UX), expanding the 3D customization options, and making it simpler for more users, including architects, interior designers, and real estate agents.

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