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AAKAR 3D ROOM DESIGNING: A REVIEW

Bhaumik Samala[1], Maaz Qureshi[2], Arpit Mejari[3], Zaibunnissa Malik[4]

[1,2,3,4]Maaz Qureshi, Bhaumik Samala, Arpit Mejari, Zeba Malik MH Saboo Siddik Polytecnic, India.

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ABSTRACT

The evolution of 3D modeling and interior design has seen significant advancements, particularly with the development of sophisticated datasets and virtual design environments. This review paper examines key technologies and methodologies in 3D room layout generation, virtual furniture modeling, and web-based visualization, with an emphasis on datasets such as 3D-FRONT and Structured3D. These resources facilitate the creation of high-quality, functional virtual spaces with enhanced style compatibility, realism, and automation in design processes [2][15]. This paper highlights recent developments, explores their impacts, and discusses future possibilities for improving efficiency and accuracy in virtual interior design workflows, while excluding augmented reality applications [1][3].

1. INTRODUCTION

Interior design and architectural modeling have transitioned significantly from traditional,manual processes to sophisticated digital environments that allow for detailed visualization and design. The introduction of virtual reality (VR) and 3D modeling technologies has enabled designers to create realistic, fully furnished virtual spaces that assist in decision-making and planning [4][5][9].

However, one of the primary challenges in interior design has always been the ability to predict and visualize the final outcome before implementation. Virtual environments equipped with 3D modeling and rendering technologies help address these challenges by allowing designers to virtually arrange furniture, experiment with layouts, and collaborate more effectively with clients [8][13]. Additionally, datasets like 3D-FRONT and Structured3D provide extensive libraries of 3D models and furniture objects that integrate seamlessly into design software, allowing designers to customize their spaces in detail [2][14][15].

This review focuses on several key areas: 3D room layout generation, furniture modeling, and web-based visualization technologies. It explores how these advancements streamline the design process, enable collaboration, and enhance design quality while excluding augmented reality solutions [1][6][7]. These technologies allow for greater efficiency and realism in creating virtual spaces, thereby transforming the field of interior design [9][17][24].

2. METHOD

A. 3D Room Layouts and Scene Generation

The development of datasets such as 3D-FRONT: 3D Furnished Rooms with Layouts and Semantics [2] and Structured3D: A Large Photo-realistic Dataset for Structured 3D Modeling [15] has had a significant impact on interior design. These datasets provide comprehensive, professionally curated 3D room layouts populated with furniture models that are stylistically compatible [16][17].

The 3D-FRONT dataset contains over 18,000 rooms, fully furnished with 3D models that maintain high-quality textures [2][10][14]. This dataset has proven particularly useful in automating room layout generation and scene synthesis, supporting designers in developing virtual spaces that align with professional standards of aesthetic appeal and functionality [12][22].

In addition, tools such as DeepRoom: 3D Room

Layout and Pose [6] and Graph2Plan: Learning Floorplan Generation from Layout Graphs [24] allow for the automatic generation of room layouts based on spatial data and deep learning techniques [5][19]. These models predict optimal object placements and floor layouts using machine learning, significantly reducing the manual effort required by designers. This enables a more efficient workflow, wherein designers can spend less time on tedious adjustments and focus more on creativity and customization [6][18][20].

B. 3D Furniture Modeling and Texturing

An integral part of interior design is furniture modeling and texturing. Datasets like 3D-FUTURE: 3D Furniture Shape with Texture [14] and FurniScene: A Large-scale 3D Room Dataset with Intricate Furnishing Scenes [7] offer a rich variety of furniture models with high-quality textures, allowing designers to create realistic and functional room layouts [13][17]. These datasets allow designers to place furniture in virtual rooms and assess its impact on the overall design, ensuring both aesthetic and functional compatibility [7][11][14]. The focus on texture and style allows for diverse customization, giving designers the flexibility to adjust objects to their client's needs [7][28].

For example, Two Layer 3D Floor Planning [18] introduces a multi-layer approach for furniture arrangement, providing more flexibility in how objects are placed in a 3D space [18][26]. The system ensures that objects do not overlap or interfere with each other, improving the efficiency and accuracy of the design process [18][27]. By integrating high-quality models with algorithms that maintain functional layout consistency, designers are able to create more realistic and engaging environments [14][25].

C. Web-based Visualization and Rendering

The ability to visualize designs in real-time is essential for both designers and clients. Technologies like WebGL and Three.js offer solutions for rendering and interacting with 3D models within a browser, making the design process more accessible [26][19][28]. Indoor3D: a WebGL-based open-source framework for 3D indoor maps visualization [19] and Rendering interactive 3D scene as a

web-page using Three.js, WebGL, and Blender [26] showcase the potential of web-based tools in allowing users to interact with 3D scenes directly through web interfaces [22][25].

These tools enable real-time manipulation of 3D environments, giving users the ability to modify layouts, furniture arrangements, and textures without the need for specialized software [26][27][19]. This makes the design process not only faster but also more collaborative, as clients can interact with the design in real-time, providing feedback instantly [19][28]. Such visualization technologies are integral in closing the gap between designers and their clients, fostering better communication and more aligned final outputs [26][27].

3. RESULTS

A. Efficiency in Design Process

The combination of automated layout generation tools and large- scale datasets has drastically improved the efficiency of the design process [2][14]. Datasets like 3D-FRONT, when combined with algorithms such as Graph2Plan and DeepRoom [24][6], allow designers to generate entire room layouts automatically [2][10].

This has led to significantly reduced project turnaround times, as much of the manual work involved in planning and organizing furniture placement is now handled by machine learning models [6][24].

The introduction of these tools has also resulted in more streamlined workflows for designers. Rather than manually adjusting furniture arrangements and room layouts, designers can focus on customizing finer details of the space, such as lighting, materials, and textures, which ultimately improves the overall quality of the design [14][22][25].

B. Improved Realism and Customization

One of the primary benefits of datasets like 3D-FUTURE and FurniScene [14][7] is the level of realism they provide [14][7]. The inclusion of high-quality textures and style compatibility in these datasets allows for a more lifelike representation of virtual environments [7][11]. Designers can customize spaces according to specific client preferences, altering the texture, color, and material of furniture pieces to achieve the desired aesthetic [13][14].

Furthermore, the use of texture synthesis algorithms enhances the visual appeal of 3D models, allowing designers to experiment with different design schemes without compromising on quality [14][11]. This ability to generate variations on standard models helps make the virtual environment more dynamic and engaging for users [28][7].

C. Real-time Interaction and Visualization

Web-based rendering solutions have improved

the accessibility of 3D design tools. By utilizing platforms like Three.js and WebGL, designers

and clients can interact with and manipulate 3D models in real- time. This reduces the need for complex software installations and allows for collaborative design processes that are more intuitive and user-friendly.

D. Improved Collaboration and Accessibility

The application of WebGL and Three.js has also improved the accessibility and collaboration involved in interior design [26][19]. By enabling real-time interaction with 3D models in a browser **environment**, designers can work more closely with their clients, who are able to provide immediate feedback on design choices [19][26]. This fosters a more collaborative design process and reduces the likelihood of miscommunication or dissatisfaction with the final result [27][28].

Moreover, these web-based tools lower the barrier to entry for smaller design firms or freelance designers who may not have access to expensive software [28][19]. By providing these capabilities in a browser, designers are able to offer high-quality services without the need for costly infrastructure [19][27].

4. DISCUSSION

The advancements in 3D modeling and scene generation discussed in this review have significantly changed the landscape of interior design [2][14][19]. Automated tools like Graph2Plan and DeepRoom [24][6] offer new possibilities for reducing the time and effort involved in creating room layouts [6][24]. These innovations, combined with comprehensive datasets like 3D- FRONT, allow for more flexibility and customization, enabling designers to meet client expectations more effectively [2][14].

However, there are still areas that require improvement. While these datasets provide a vast array of models and textures, they may still fall short when faced with highly specific or niche client requests [7][28]. Future developments should focus on expanding the range of customizable options available to designers, particularly in terms of furniture and lighting [15][18]. Additionally, further integration between various design elements, such as lighting, color schemes, and furniture placement, would ensure a more cohesive virtual environment [18][28].

In the future, we expect to see even greater advancements in the automation and customization of 3D interior design tools [6][15]. The ability to generate entire virtual spaces with minimal input from designers will not only save time but also enable designers to explore more creative possibilities within their projects [6][24].

5. CONCLUSION

The convergence of large-scale 3D datasets, automated layout generation algorithms, and web-based rendering technologies has transformed the interior design industry. Tools like 3D- FRONT and Structured3D provide designers with the necessary resources to create realistic, functional, and aesthetically pleasing environments. WebGL and Three.js, on the other hand, enable real-time interaction and collaboration, making the design process more accessible and efficient.

These advancements have not only streamlined the design process but also enhanced the final output, providing more personalized and realistic designs for clients. As technology continues to evolve, further improvements in automation, customization, and accessibility will shape the future of virtual interior design.

6. REFRENCES

[1] RoomifyAR: Rendering Multiple Models to Design a Room DOI: 10.1109/ICAAIC60222.2024.10575841 Authors: Harsh Koli, Yash Jagdale, Bushra Shaikh, Parag Dudhmal

[2] 3D-FRONT: 3D Furnished Rooms with Layouts and Semantics DOI: 10.1109/ICCV48922.2021.01075 Authors: Huan Fu, Bowen Cai, Lin Gao, Ling-Xiao Zhang, Jiaming Wang, Cao Li, Qixun Zeng, Chengyue Sun, Rongfei Jia, Binqiang Zhao, Hao Zhang

[3] Furnished: An Augmented Reality Based Approach Towards Furniture Shopping DOI: 10.17577/IJERTV10IS050253 Authors: Syamantak N. Dhavle, Bhavna Arora, Chaudhary Mohammed Qais, Khan Mohd Saif Tabarakallah

[4] Interior Design and Decoration Style Based on 3D Computer Software and Virtual Reality Technology DOI: 10.1109/ICAISC58445.2023.10199464 Authors: Chen Wen

[5] From Floor Plans to Virtual Reality DOI: 10.1109/AIVR52153.2021.00030 Authors: Timothee Freville, Charles Hamesse, Benoit Pairet, Rihab Lahouli, Rob Haelterman

[6] DeepRoom: 3D Room Layout and Pose DOI: https://doi.org/10.1007/978-3-030-41299-9_56 Authors: Hung Jin Lin and Shang-Hong Lai

[7] FurniScene: A Large-scale 3D Room Dataset with Intricate Furnishing Scenes DOI: https://doi.org/10.48550/arXiv.2401.03470 Authors: Genghao Zhang, Yuxi Wang, Chuanchen Luo, Shibiao Xu

[8] 3D Room Layout Estimation From a Single RGB Image DOI: 10.1109/TMM.2020.2967645 Authors: Chenggang Yan; Biyao Shao; Hao Zhao; Ruixin Ning

[9] 3D-FRONT: 3D Furnished Rooms with Layouts and Semantics DOI: https://doi.org/10.48550/arXiv.2011.09127 Authors: Huan Fu, Bowen Cai, Lin Gao, Ling-Xiao Zhang, Jiaming Wang, Cao Li, Qixun Zeng, Chengyue Sun, Rongfei Jia, Binqiang Zhao, Hao Zhang

[10] Application and Development Prospect of Monitoring Screen based on Three.js 8nit Equipment Control System DOI: 10.1109/QRS-C57518.2022.00058 Authors: Boying Wu; Sigong Zhang; Weirong Tian; Hang Wang

[11] A Service-Oriented Approach for Classifying 3D Point Clouds: An Example of Office Furniture Classification DOI: 10.1145/3208806.3208810 Authors: Vladeta Stojanovic,Matthias Trapp,Rico Richter,Jürgen Döllner

[12] I-Design: Personalized LLM Interior Designer DOI: https://doi.org/10.48550/arXiv.2404.02838 Authors: Ata Çelen1, Guo Han1, Konrad Schindler1, Luc Van Gool1, Iro Armeni2∗,Anton Obukhov1∗, and Xi Wang1∗

[13] Ctrl-Room: Controllable Text-to-3D Room Meshes Generation with Layout Constraints DOI: https://doi.org/10.48550/arXiv.2310.03602 Authors: Chuan Fang1,2, Xiaotao Hu2,3, Kunming Luo1,2, Ping Tan1,2,

[14] 3D-FUTURE: 3D Furniture Shape with Texture DOI: https://doi.org/10.48550/arXiv.2009.09633 Authors: Huan Fu, Bowen Cai, Lin Gao, Binqiang Zhao, Rongfei Jia, Hao Zhang

[15] Structured3D: A Large Photo-realistic Dataset for Structured 3D Modeling DOI: https://doi.org/10.48550/arXiv.1908.00222 Authors: Jia Zheng, Junfei Zhang, Jing Li, Rui Tang, Shenghua Gao, Zihan Zhou

[16] Analysis and Modeling of 3D Indoor Scenes DOI: https://doi.org/10.48550/arXiv.1706.0957 Authors: Rui Ma

[17] Automatic Digitization and Orientation of Scanned Mesh Data for Floor Plan and 3D Model Generation DOI: https://doi.org/10.48550/arXiv.2311.11927 Authors: Ritesh Sharma, Eric Bier, Lester Nelson, Mahabir Bhandari, Niraj Kunwar

[18] Two Layer 3D Floor Planning DOI: https://doi.org/10.48550/arXiv.1210.459 Authors: Paul Horn, Gabor Lippner

[19] Indoor3D: a WebGL based open-source framework for 3D indoor maps visualization DOI: https://doi.org/10.3390/ijgi904023 Authors: Meng Gai, Guoping Wang

[20] A Web-Based 3D System for Home Design DOI: 10.1007/978-3-642-02710-9_4 Authors: Anthony Chong, Ji-Hyun Lee, and Jieun Park

[21] Designing Small Homes: An Interior Design Studio Project DOI: 10.15341/jmer(2155-7993)/04.04.2014/007 Authors: Kenneth R Tremblay Katharine Leigh Colorado State University Laura Malinin Colorado State University Amy M Huber

[22] Generation of 3D Building Models from 2D Architectural Plans DOI: https://doi.org/10.1016/S0010-4485(98)00031-1 Authors: Rick Lewis a ,Carlo Séquin

[23] Reconstruction of 3D Virtual Buildings from 2D Architectural Floor Plans DOI: Unknown (Details not available) Author: Clifford So ,George Bach, Hanqiu Sunt

[24] Graph2Plan: Learning Floorplan Generation from Layout Graphs DOI: Unknown (Details not available) Author: Ruizhen Hu, Zeyu Huang, Yuhan Tang, Oliver Van Kaick, Hao Zhang, Hui Huang

[25] 3D Graphics on the Web: A Survey DOI: https://doi.org/10.1016/j.cag.2014.02.002 Authors: Alun Evans Marco Romeo Arash Bahrehmand Javi Agenjo Josep Blat

[26] Rendering Interactive 3D Scenes as a Web-page Using Three.js, WebGL, and Blender DOI: http://hdl.handle.net/10361/18249 Authors: Sudeepto Bose

[27] 3D Data Integration for Web-Based Open Source WebGL Interactive Visualization DOI: 10.5194/isprs-archives-XLVIII-4-W4-2022-89-2022 Authors: M. La Guardia 1*, M. Koeva 2, F. D'Ippolito 1,S. Karam 2

[28] A Survey of Real-Time Rendering on Web3D Applications DOI: https://doi.org/10.1016/j.vrih.2022.04.002 Authors: Geng YU1, Chang LIU1*, Ting FANG1, Jinyuan JIA2, Enming LIN1, Yiqiang HE1,Siyuan FU1, Long WANG1 , Lei WEI1, Qingyu HUANG

[29] HTML5/WebGL vs Flash in 3D Visualization DOI: Unknown (Details not available) Author : Senad Bahor

[30] Style Compatibility for 3D Furniture Models DOI: https://doi.org/10.1145/2766898 Authors: Tianqiang Liu1 Aaron Hertzmann2 Wilmot Li2 Thomas Funkhouser1