Skematix: Automated AI-Based Conversion of 2D Floor Plans into 3D and AR Visualizations

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***Abstract*—Architectural designs are predominantly communicated using two-dimensional (2D) floor plans, which often fail to provide an intuitive understanding of spatial relationships for non-technical stakeholders. Manual conversion of these plans into three-dimensional (3D) models is time-consuming, expensive, and requires specialized expertise. This paper presents Skematix, an automated AI-based system that converts scanned or hand-drawn 2D floor plans into interactive 3D and augmented reality (AR) visualizations. The proposed approach integrates computer vision-based preprocessing with deep learning-driven semantic segmentation to detect architectural elements such as walls, doors, windows, and rooms. A structured 3D model is generated automatically using the Blender Python API and visualized through a browser-based WebXR interface. Experimental evaluation demonstrates that the system preserves spatial accuracy while significantly reducing modeling time and user effort. Skematix improves architectural communication, enhances design understanding, and provides an accessible visualization platform without requiring specialized CAD software.**

***Index Terms*—Augmented Reality, Computer Vision, Deep Learning, Floor Plan Analysis, Semantic Segmentation, 2D to 3D Conversion.**

I. INTRODUCTION

Architectural design is primarily communicated through two-dimensional (2D) floor plans that describe layout and structure. While these drawings are precise for professionals, they often fail to convey spatial understanding to non-technical stakeholders, leading to confusion during design discussions.

Three-dimensional (3D) visualization improves spatial perception and design clarity. However, converting 2D plans into 3D models generally requires specialized software and expert knowledge, making the process time-consuming and inaccessible to many users.

Recent research applies computer vision and deep learning to automate floor plan analysis. Although these approaches show promising results in structural detection, many lack semantic room understanding and do not provide user-friendly visualization platforms.

To overcome these limitations, this paper presents Skematix, an AI-based system that automatically transforms 2D floor plans into interactive 3D and augmented reality (AR) visualizations. The proposed system reduces manual effort and enhances architectural communication through accessible, browser-based visualization.

II. LITERATURE REVIEW

Initial approaches to architectural visualization relied on manual 3D modeling using CAD and BIM tools, which provided accurate representations but required significant expertise and time. These limitations restricted their usability for rapid visualization and non-technical users.

Subsequent research explored computer vision techniques to automatically extract structural elements from 2D floor plans. While traditional image processing methods achieved partial success, they struggled with noisy inputs and hand-drawn sketches.

Recent advancements in deep learning, particularly semantic segmentation models such as U-Net, significantly improved floor plan understanding. However, most existing systems focus mainly on geometric reconstruction and lack semantic room interpretation and accessible visualization platforms, motivating the development of an integrated solution like Skematix.

III. MATERIALS AND METHODS

The Skematix system implements an automated pipeline for converting two-dimensional (2D) floor plans into interactive three-dimensional (3D) and augmented reality (AR) visualizations. The methodology is executed through the following stages:

1. Input Acquisition

Scanned blueprints and hand-drawn floor plan images are provided as input to the system.

2. Image Preprocessing

Computer vision techniques using OpenCV are applied for grayscale conversion, noise removal, binarization, and edge enhancement to improve structural clarity.

3. Semantic Segmentation

A U-Net deep learning model trained on the CubiCasa5k dataset performs pixel-level segmentation to identify walls, rooms, doors, and windows.

4. Feature Extraction

Segmented outputs are processed to extract vector representations while preserving spatial relationships and room connectivity.

5. 3D Model Generation

The extracted features are automatically converted into a structured 3D model using the Blender Python API.

6. Visualization and Interaction

The generated 3D model is rendered using Three.js and integrated with WebXR to enable real-time interaction and AR visualization in a web browser.

IV. RESULT AND DISCUSSION

The performance of the proposed Skematix system was evaluated based on accuracy of architectural element detection, quality of generated 3D models, and reduction in manual modeling effort. Experimental results demonstrate that the system successfully processes scanned and hand-drawn floor plans and produces semantically meaningful 3D reconstructions.

The semantic segmentation model achieved reliable detection of walls, rooms, doors, and windows, preserving spatial relationships between architectural elements. The automated 3D models generated using the Blender Python API maintained correct proportions and room connectivity when compared with the original 2D layouts. This confirms the effectiveness of combining computer vision preprocessing with deep learning-based segmentation. In comparison with manual 3D modeling, the proposed approach significantly reduced modeling time, achieving an estimated reduction of approximately 83–88%. The integration of WebXR further enhanced usability by enabling real-time browser-based interaction and augmented reality visualization without requiring specialized software installations. These results highlight the practical applicability of Skematix for architectural visualization and design communication.

A. Figures

Fig. 1. System architecture of the proposed Skematix framework for automated 2D floor plan to 3D and AR visualization.

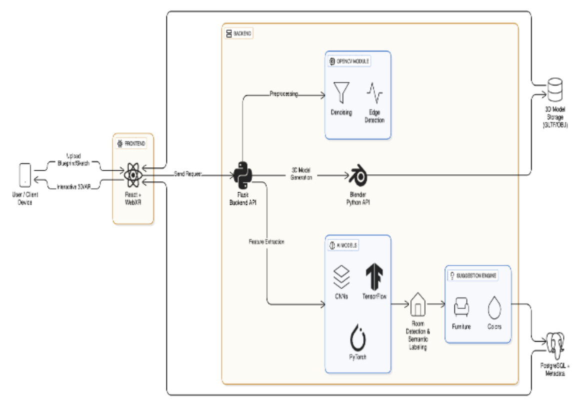

Fig. 1. System Architecture of Skematix.

V. CONCLUSION

This paper presented Skematix, an AI-based system designed to automate the transformation of two-dimensional (2D) floor plans into interactive three-dimensional (3D) and augmented reality (AR) visualizations. The proposed framework integrates computer vision-based preprocessing, deep learning-driven semantic segmentation, and automated 3D reconstruction to address the limitations of traditional manual modeling approaches. By accurately detecting architectural elements such as walls, rooms, doors, and windows, the system preserves spatial relationships and layout consistency during 3D generation.

The experimental results demonstrate that Skematix significantly reduces modeling time and user effort while maintaining reliable visualization quality. The inclusion of browser-based interaction and AR visualization further enhances accessibility, allowing users to explore architectural designs without requiring specialized CAD or BIM software. This makes the system particularly useful for early-stage design validation, client communication, and educational applications.

Future enhancements will focus on improving robustness for complex floor plans, refining semantic understanding of interior elements, and expanding intelligent design recommendations. Overall, Skematix provides an efficient and accessible solution for AI-driven architectural visualization and supports improved decision-making in design workflows.

VI. AUTHOR CONTRIBUTIONS

1. Dhirajkumar Pachling conceptualized the overall system architecture, defined the research methodology, and prepared the original draft of the manuscript.
2. Sarth Gaikwad contributed to the development and training of the deep learning model and validation.
3. Diksha Kapse implemented the automated three-dimensional model generation pipeline and developed the augmented reality (AR) components.
4. Pratik Vidhate assisted in data collection, data cleaning, preprocessing, evaluation and results.

All authors critically reviewed the manuscript, provided feedback, and approved the final version for submission.

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REFERENCES

[1] S. Liu, J. Yang, and H. Zhao, “Deep learning-based floor plan recognition and reconstruction,” *IEEE Access*, vol. 8, pp. 221566–221578, 2020.

[2] J. K. Jang and S. Lee, “Automatic 2D floor plan to 3D building model generation using computer vision,” *Computer-Aided Design*, vol. 114, pp. 64–75, 2019.

[3] A. Sirinukunwattana et al., “Semantic segmentation of architectural floor plans using deep learning,” *Pattern Recognition Letters*, vol. 138, pp. 191–198, 2020.

[4] S. Park and H. Kim, “3DPlanNet: Generating 3D models from 2D floor plan images using ensemble methods,” *Electronics*, vol. 10, no. 22, pp. 1–15, Nov. 2021.

[5] R. Szeliski, *Computer Vision: Algorithms and Applications*, 2nd ed. New York, NY, USA: Springer, 2022, ch. 9, pp. 401–450.

[6] I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016, ch. 6, pp. 185–220.

[7] C. Liu, J. Wu, P. Kohli, and Y. Furukawa, “Raster-to-vector: Revisiting floorplan transformation,” in *Proc. IEEE Int. Conf. Computer Vision (ICCV)*, Venice, Italy, 2017, pp. 2195–2203.

[8] M. Honari et al., “CubiCasa5k: A dataset and an improved multi-task model for floor plan image analysis,” in *Proc. Scandinavian Conf. Image Analysis (SCIA)*, Springer, 2019, pp. 28–40.

[9] P. Deshmukh, S. Patil, and R. Kulkarni, “2D to 3D floor plan modeling using image processing and augmented reality,” in *Proc. IEEE Int. Conf. Recent Advances in Electrical, Electronics & Digital Healthcare Technologies (REEDCON)*, New Delhi, India, 2023, pp. 682–687.

[10] A. C. Barreiro, M. Trzeciakiewicz, A. Hilsmann, and P. Eisert, “Automatic reconstruction of semantic 3D models from 2D floor plans,” presented at the 18th Int. Conf. Machine Vision Applications (MVA), Hamamatsu, Japan, 2023.

[11] G. Bradski, “The OpenCV Library,” Dr. Dobb’s Journal of Software Tools, 2000. [Online]. Available: https://opencv.org

[12] Blender Foundation, “Blender—A 3D creation suite,” 2024. [Online]. Available: https://www.blender.org

[13] R. Cabello et al., “Three.js: JavaScript 3D library,” 2024. [Online]. Available: https://threejs.org

[14] J. Canny, “A computational approach to edge detection,” IEEE Trans. Pattern Analysis and Machine Intelligence, vol. PAMI-8, no. 6, pp. 679–698, 1986.