

Enhancing Residential Architecture through Generative Design: Balancing Aesthetics, Legal Constraints, and Environmental Considerations

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Abstract : This research paper presents an in-depth exploration of the use of generative design in urban residential architecture, with a dual focus on aligning aesthetic values with legal and environmental constraints. The study aims to demonstrate how generative design methodologies can innovate residential building designs that are not only legally compliant and environmentally conscious but also aesthetically compelling. At the core of our research is a specially developed generative design framework tailored for urban residential settings. This framework employs computational algorithms to produce diverse design solutions, meticulously balancing aesthetic appeal with practical considerations. By integrating site-specific features, urban legal restrictions, and environmental factors, our approach generates designs that resonate with the unique character of urban landscapes while adhering to regulatory frameworks. The paper explores how modern digital tools, particularly computational design, and algorithmic modelling, can optimize the early stages of residential building design. By creating a basic parametric model of a residential district, the paper investigates how automated design tools can explore multiple design variants based on predefined parameters (e.g., building cost, dimensions, orientation) and constraints. The paper aims to demonstrate how these tools can rapidly generate and refine architectural solutions that meet the required criteria for quality of life, cost efficiency, and functionality. The study utilizes computational design for database processing and algorithmic modelling within the fields of applied geodesy and architecture. It focuses on optimizing the forms of residential development by adjusting specific parameters and constraints. The results of multiple iterations are analysed, refined, and selected based on their alignment with predefined quality and cost criteria. The findings of this research will contribute to a modern, complex approach to residential area design. The paper demonstrates the potential for integrating BIM models into the design process and their application in virtual 3D Geographic Information Systems (GIS) environments. The study also examines the transformation of BIM models into suitable 3D GIS file formats, such as CityGML, to facilitate the visualization and evaluation of urban planning solutions. In conclusion, our research demonstrates that a generative parametric approach based on real geodesic data and collaborative decision-making could be introduced in the early phases of the design process. This gives the designers powerful tools to explore diverse design possibilities, significantly improving the qualities of the investment during its entire lifecycle.

Keywords : architectural design, residential buildings, urban development, geodesic data, generative design, parametric models, workflow optimization

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