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Beyond Geometry: The Importance of Surface Properties in Space Syntax Research

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Abstract : Space syntax is a theory and method for analyzing the spatial layout of buildings and urban environments to understand how they can influence patterns of human movement, social interaction, and behavior. While direct visibility is a key factor in space syntax research, important visual information such as light, color, texture, etc., are typically not considered, even though psychological studies have shown a strong correlation to the human perceptual experience within physical space – with light and color, for example, playing a crucial role in shaping the perception of spaciousness. Furthermore, these surface properties are often the visual features that are most salient and responsible for drawing attention to certain elements within the environment. This paper explores the potential of integrating these factors into general space syntax methods and visibility-based analysis of space, particularly for architectural spatial layouts. To this end, we use a combination of geometric (isovist) and topological (visibility graph) approaches together with image-based methods, allowing a comprehensive exploration of the relationship between spatial geometry, visual aesthetics, and human experience. Custom-coded ray-tracing techniques are employed to generate spherical panorama images, encoding three-dimensional spatial data in the form of two-dimensional images. These images are then processed through computer vision algorithms to generate saliency-maps, which serve as a visual representation of areas most likely to attract human attention based on their visual properties. The maps are subsequently used to weight the vertices of isovists and the visibility graph, placing greater emphasis on areas with high saliency. Compared to traditional methods, our weighted visibility analysis introduces an additional layer of information density by assigning different weights or importance levels to various aspects within the field of view. This extends general space syntax measures to provide a more nuanced understanding of visibility patterns that better reflect the dynamics of human attention and perception. Furthermore, by drawing parallels to traditional isovist and VGA analysis, our weighted approach emphasizes a crucial distinction, which has been pointed out by Ervin and Steinitz: the difference between what is possible to see and what is likely to be seen. Therefore, this paper emphasizes the importance of including surface properties in visibility-based analysis to gain deeper insights into how people interact with their surroundings and to establish a stronger connection with human attention and perception.

Keywords : space syntax, visibility analysis, isovist, visibility graph, visual features, human perception, saliency detection, raytracing, spherical images
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