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Designing for Perception: Weather-Aware Streetscapes via Generative Modeling and Global Datasets

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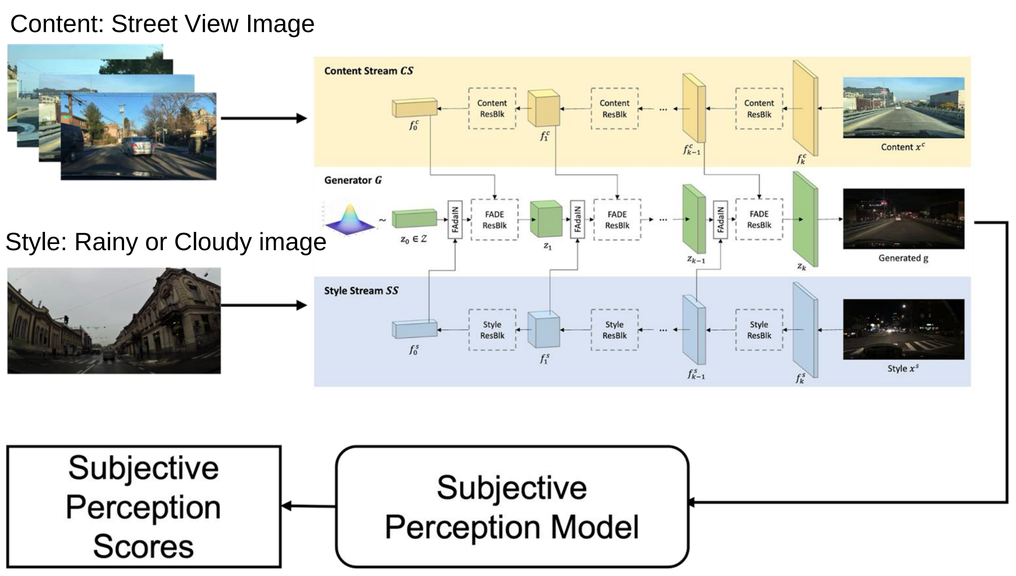
Background

Urban streetscape evaluation is shifting from expert-led, objective methods to approaches that focus more on how people actually feel in these environments. Traditional analysis looks at visible features like trees, signs, and buildings using computer vision, but often misses subtle factors like lighting and weather that strongly affect how safe or pleasant a place feels. Current methods usually follow professional design rules, which don't always match how regular people experience city spaces. To close this gap, our work focuses on everyday users' feelings and preferences, aiming to build a more inclusive and human-centered way to assess urban streetscapes.

Workflow



Dataset

We used large-scale street view datasets for our study. We sampled 88,000 images from a global, open-access platform that crowdsources street-level imagery from diverse regions, climates, cultures, and devices—capturing the rich visual variety of real-world urban scenes. Each image was automatically labeled with weather conditions (e.g., sunny, cloudy, rainy) for use in image generation and analysis.

Generation Result Analysis

To ensure the validity of our findings, we evaluated the visual quality of the generated image. The FID scores were 6.6 for cloudy images and 7.1 for rainy images, indicating strong realism and supporting the reliability of our subjective perception analysis.

Subjective Perception Analysis

Across 88,000 images, sunny scenes scored on average 89.61% higher than cloudy ones, and cloudy scenes scored 86.77% higher than rainy ones. Sunny weather led to the greatest increases in dimensions like ***bright***, ***neat***, ***open***, ***beautiful***, and ***clean***—all improving by over 110% compared to cloudy conditions. Compared to rainy scenes, sunny ones scored even higher, especially in ***cozy*** and ***desirable*** aspects.
Even between cloudy and rainy weather, the *beautiful* dimension rose by over 240%, with ***clean***, ***like***, and ***livable*** increasing over 200%. Meanwhile, negative feelings such as ***boring*** and ***depressing*** were highest under rainy conditions. Perceptions of ***interesting*** and ***greenery*** remained relatively stable across weather types, showing less sensitivity to ambiance.

	sunny	cloudy	rainy
Depressing	-6.464961	-5.684566	-5.187871
Lively	1.092502	1.451679	1.292686
Old-fashioned	-4.689261	-4.437438	-4.057524
Lived-in feel	-7.936947	-7.689932	-7.738009
Greenery	-3.306697	-3.154641	-3.597596
Interesting	-0.764434	-0.696094	-0.842017
Boring	-1.954442	-2.12858	-1.768591
Wealthy	0.452845	0.190802	-0.400223
Comfortable	6.681872	6.029698	5.415736
Friendly	-2.427908	-3.08456	-3.37419
Desirable for going	9.879668	9.135197	8.661799
Desirable for living	1.479641	0.685421	0.008922
Attractive	5.014578	4.214613	3.601729
Like	5.460554	4.594353	3.956481
Cozy	2.397264	1.345886	0.734363
Safe	2.290703	1.231949	0.86037
Calm	-0.526047	-1.686662	-2.125419
Clean	6.988525	5.780725	5.15681
Beautiful	2.817921	1.5394	0.811324
Open	3.960528	2.677644	2.580865
Neat	4.924714	3.263427	3.065354
Bright	3.118989	1.446466	0.989144

Highest
Lowest