专业外语
Professional English in Architecture

李韵琴
南昌大学建筑与设计学院
2023年4月6日
2023年4月13日

南昌大学 NanChang University

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《专业外语》教学大纲

1. 课程概论(3月2日)
2. 建筑学专业词汇 (3月9日)
3. 视听训练 (3月16日)
4. 视听训练(3月23日)
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11. 互动作业汇报(5月11日)
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专业文献精读

第六讲

第七讲

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科技论文精读

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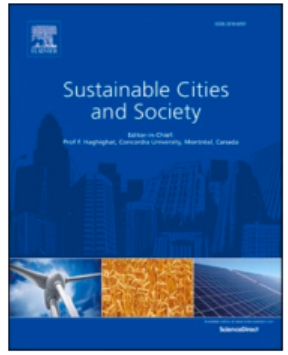

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Measuring visual walkability perception using panoramic street view images, virtual reality, and deep learning

Yunqin Li, Nobuyoshi Yabuki *, Tomohiro Fukuda

Division of Sustainable Energy and Environmental Engineering, Graduate School of Engineering, Osaka University, Japan

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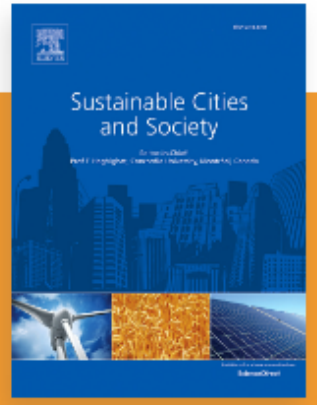
- *Sustainable Cities and Society (SCS)* is an international journal focusing on fundamental and applied research aimed at designing, understanding, and promoting **environmentally** sustainable and **socially** resilient **cities**.



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About the journal

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Words and Phrases

- Panoramic 全景的
- Panorama 全景
- Semantic segmentation 语义分割
- Deep learning 深度学习
- Interpretable deep learning 可解释深度学习
- Built environment 建成环境
- Pedestrian 行人
- Accessibility 可达性
- Feasibility 可行性
- stepwise regression 逐步回归

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List of abbreviations

Abbreviation	Meaning	
CNN	Convolutional Neural Networks	卷积神经网络
DCNN	Deep Convolutional Neural Networks	深度卷积神经网络
GIS	Geographical Information System	地理信息系统
MOT	Mutiple Object Tracking	多目标跟踪
POI	Point of Interest	兴趣点
SVI	Street View Image	街景图片
VWP	Visual Walkability Perception	视觉步行性感知
VWPCL	VWP classification deep multitask learning	VWP分类深度多任务学习
VR	Virtual Reality	虚拟现实
VRVWPR	VR Visual Walkability Perceptual Ratings	VR视觉步行能力的感知评分
Grad-CAM	gradient-weighted class activation mapping	梯度加权类激活图谱

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Title

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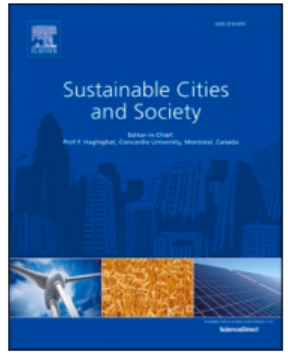

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Measuring visual walkability perception using panoramic street view images, virtual reality, and deep learning

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Title

Review Articles

Review article ○ Abstract only

Algorithmic urban planning for smart and sustainable development: Systematic review of the literature

Tim Heinrich Son, Zack Weedon, Tan Yigitcanlar, Thomas Sanchez, ... Rashid Mehmood
Article 104562

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Regular Articles

Research article ○ Abstract only

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Predicting the ammonia nitrogen of wastewater treatment plant influent via integrated model based on rolling decomposition method and deep learning algorithm

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An unsupervised method to exploit low-resolution water meter data for detecting end-users with abnormal consumption: Employing the DBSCAN and time series complexity

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Article 104516

Article preview

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Abstract

A B S T R A C T

Measuring perceptions of visual walkability in urban streets and exploring the associations between the visual features of the street built environment that make walking attractive to humans are both theoretically and practically important. Previous studies have used either environmental audits and subjective evaluations that have limitations in terms of cost, time, and measurement scale, or computer-aided audits based on natural street view images (SVIs) but with gaps in real perception. In this study, a virtual reality panoramic image-based deep learning framework is proposed for measuring visual walkability perception (VWP) and then quantifying and visualizing the contributing visual features. A VWP classification deep multitask learning (VWPCL) model was first developed and trained on human ratings of panoramic SVIs in virtual reality to predict VWP in six categories. Second, a regression model was used to determine the degree of correlation of various objects with one of the six VWP categories based on semantic segmentation. Furthermore, an interpretable deep learning model was used to assist in identifying and visualizing elements that contribute to VWP. The experiment validated the accuracy of the VWPCL model for predicting VWP. The results represent a further step in understanding the interplay of VWP and street-level semantics and features.

Abstract

- Measuring perceptions of visual walkability in urban streets and exploring the associations between the visual features of the street built environment that make walking attractive to humans are both theoretically and practically important.
- 衡量城市街道视觉步行性的感知，探索街道建筑环境的视觉特征之间的关联，使步行对人类产生吸引力，在理论上和实践上都很重要。

Abstract

- Previous studies have used either environmental audits and subjective evaluations that have limitations in terms of cost, time, and measurement scale, or computer-aided audits based on natural street view images (SVIs) but with gaps in real perception.
- 以前的研究要么使用环境审计和主观评价，这些评价在成本、时间和测量规模方面都有局限性，要么使用基于自然街景图像（SVI）的计算机辅助审计，但在真实感知方面存在差距。

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Abstract

- In this study, a virtual reality panoramic image-based deep learning framework is proposed for measuring visual walkability perception (VWP) and then quantifying and visualizing the contributing visual features.
- 在这项研究中，我们提出了一个基于虚拟现实全景图像的深度学习框架，用于测量视觉步行感知（VWP），然后量化和可视化贡献的视觉特征。

Abstract

- A VWP classification deep multitask learning (VWPCL) model was first developed and trained on human ratings of panoramic SVIs in virtual reality to predict VWP in six categories. Second, a regression model was used to determine the degree of correlation of various objects with one of the six VWP categories based on semantic segmentation. Furthermore, an interpretable deep learning model was used to assist in identifying and visualizing elements that contribute to VWP.
- 首先开发了一个VWP分类深度多任务学习（VWPCL）模型，并对人类在虚拟现实中对全景SVI的评分进行了训练，以预测六个类别的VWP。其次，在语义分割的基础上，使用回归模型来确定各种物体与六个VWP类别之一的相关程度。此外，一个可解释的深度学习模型被用来协助识别和可视化有助于VWP的元素。

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Abstract

- The experiment validated the accuracy of the VWPCL model for predicting VWP. The results represent a further step in understanding the interplay of VWP and street-level semantics and features.
- 该实验验证了VWPCL模型预测VWP的准确性。这些结果代表了在理解VWP和街道层面的语义和特征的相互作用方面的进一步进展。

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Highlights & Keywords

ARTICLE INFO

Keywords:
Visual walkability perception (VWP)
Panoramic street view images
Virtual reality
Deep learning
Built environment

Highlights

- Six categories of visual walkability perception (VWP) were proposed.
- VWP was measured with VR panoramic-based deep learning framework.
- A VWP classification deep multitask learning model was developed.
- Stepwise regression analysis identified contributing visual elements.
- VWP was interpreted with gradient-weighted class activation mapping.

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Headings

- **文章结构**
- 提问：分为几部分？每部分什么功能？

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Headings

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Headings

- 4 Experiment and results
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- 5 Discussion
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Manuscript Structure

Title

Abstract

1. **Introduction**

(Literature review)

2. **Methods**

(Experiments)

3. **Results**

4. **Discussion**

5. **Conclusion**

References

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Manuscript Structure

- **手稿结构和内容**- 除了短的 Perspective Essays 和 Comments，作者应该使用这种数字结构在手稿中包含不同的部分，最多三个级别的副标题：1.、1.1.、1.1.1.、2 等。 大多数手稿研究报告应遵循标准结构和内容：
- **介绍**- 描述研究问题的性质和背景、其重要性和新颖性，以及解决该问题将如何促进您研究主题的科学和实践的进步。提供对与您的主题相关的主要文献的翔实、简明的评论，解决当前的知识状态和知识差距。参考关键经典和最新资源，展示您对文献的掌握，强调同行评审的国际研究期刊和书籍。无论您的工作是描述性的还是旨在检验假设，您的介绍都应充分说明问题并具体说明研究解决的问题或目标。
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Manuscript Structure

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- **讨论**- 反思你的发现本身以及与其他国际研究的关系。在不过度概括的情况下，推测您的发现如何适用于其他地方和情况。讨论工作的优点和缺点，以及如何在未来的研究中改进或扩展。酌情讨论您的工作对景观设计、规划、管理和/或政策的影响。
- **结论**- 总结您论文的要点，突出您希望人们记住您的工作的主要发现和影响。

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Introduction

可步行的街道和城市区域已被证明可以促进社区的社会和经济繁荣（Duncan, Aldstadt, Whalen, Melly, & Gortmaker, 2011）。街道的可步行性已经成为城市规划师和设计师在设计和建设城市社区时考虑的关键因素之一（H. Zhou等人，2019）。术语 "步行性 "通常被定义为建筑环境对出于必要、选择或社会目的而步行的人的友好和邀请程度（Abley & Hill, 2005）（Cerin等，2007），并增加行人在街道空间中步行的意愿（Ewing & Handy, 2009）。在城市社区中，个体差异在决定步行和选择步行行为方面是不可避免的，所以步行能力在很大程度上依赖于人类的感知（Wang & Yang, 2019）。可行性是一个描述环境质量的主观概念，受个人对环境是否适合步行的感知影响，因此很难进行客观的定量测量（Wang & Yang, 2019）。然而，客观地量化街道层面的步行能力，并获得关于建筑环境的物理环境和视觉信息如何影响步行者体验的知识，可以帮助制定可步行社区的设计策略（Arellana等，2020）。

Walkable streets and urban areas have been shown to promote social and economic prosperity in communities (Duncanet al., 2011). The walkability of streets has become one of the key factors that urban planners and designers consider when designing and building urban communities (Zhou et al., 2019). The term "walkability" is commonly defined as the extent to which a built environment is friendly and inviting to people (Abley & Hill, 2005) who walk out of necessity, by choice, or for social purposes (Cerin et al., 2007) and increases the willingness of pedestrians to walk in a street space (Ewing & Handy, 2009). Individual differences are inevitable in the decision to walk and choice of walking behavior in urban communities, so walkability relies heavily on human perception (Wang & Yang, 2019). Walkability is a subjective concept that describes the quality of the environment and is influenced by individual perceptions of the environment as a place suitable for walking, and thus is difficult to measure objectively and quantitatively (Wang & Yang, 2019). However, objectively quantifying walkability at the street level and gaining knowledge about how the physical setting and visual information of the built environment affect the pedestrian experience can aid in the development of design strategies for walkable neighborhoods (Arellana et al., 2020).

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Introduction

随着地图服务的快速发展，基于计算机视觉技术从街景图像（SVI）中大规模地定量测量步行能力已经成为大数据时代的一个趋势（Blečić等，2018；Fan等，2018；Wang & Yang，2019；H. Zhou等，2019；Arellana等，2020；Y. Li等，2020； Ki & Lee，2021）。由于视觉信息是人类感知环境的基石，人们提出了基于SVIs的视觉步行能力和视觉步行指数，作为行人心理和主观舒适度的衡量标准，它可以从心理绿化、视觉拥挤度、户外围墙和视觉铺装等方面近似地衡量（H. Zhou等人，2019）。然而，量化这些街景图像的物理特征的计算方法很难代表视觉步行能力的主观现场感知（Y. Li等人，2020）。因此，需要有方法来测量视觉步行感知（VWP），并探索其与街道建筑环境的视觉元素的关系。

With the rapid development of mapping services, the large-scale quantitative measurement of walkability from street view images (SVIs) based on computer vision technology has become a trend in the era of big data (Arellana et al., 2020; Blečić et al., 2018; Fan et al., 2018; Ki & Lee, 2021; Li et al., 2020; Wang & Yang, 2019; Zhou et al., 2019). Because visual information is the cornerstone of human perception of the environment, a visual walkability and visual walkability index based on SVIs has been proposed as a measure of pedestrian psychological and subjective comfort, which can be approximated from psychological greenery, visual crowdedness, outdoor enclosures, and visual pavement (Zhou et al., 2019). However, calculations that quantify the physical characteristics of these streetscape images are hardly representative of subjective on-site perceptions for visual walkability (Li et al., 2020). Therefore, methods are needed for measuring visual walkability perception (VWP) and exploring its relationship with visual elements of the street built environment.

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在早期的研究中，许多城市设计师和研究人员采取的一种方法是进行访谈和观察步行活动，根据逻辑推理找到物理外观和步行行为之间的联系，从而主观地而不是定量地测量步行能力（Wang & Yang, 2019; Saadi et al., 2022）。在另一种方法中，已经创建了许多评价步行能力的指数，每个指数都包含一些与步行能力有关的工具或检查表，通过实地调查和问卷来评估步行环境的步行能力（Wang & Yang, 2019; Campisi et al., 2021）。这些环境审计和主观评价方法在接近现实方面有明显的优势，但在成本、时间和测量规模方面有局限性。此外，它们的有效性也很难在受控实验中得到验证。

In early studies, one approach taken by many urban designers and researchers was to conduct interviews and observe walking activities to find connections between physical appearance and walking behavior based on logical reasoning, thus measuring walkability subjectively rather than quantitatively (Saadi et al., 2022; Wang & Yang, 2019). In another approach, many indices for evaluating walkability have been created, each containing some terminology related to walkability in tools or checklists to assess walkability in pedestrian environments through field surveys and questionnaires (Campisi et al., 2021; Wang & Yang, 2019). These environmental audits and subjective evaluation methods have obvious advantages in terms of approximating reality but have limitations in terms of cost, time, and measurement scale. Further, their validity is difficult to verify in controlled experiments.

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Introduction

近年来，基于自然SVI的计算机辅助审核方法已经出现，能够客观地审核大量与步行能力相关的街景元素（Blečić等人，2018年），缓解了以往人工评估样本量不足的缺点，并使这些方法易于应用于不同城市的比较（Y. Li等人，2020年）。然而，这些方法在捕捉和直观地揭示真实的现场步行能力感知方面存在差距（Kim & Lee，2022）。例如，一些需要空间感和类似真实度的感知，如人的尺度、围墙，在基于浏览器的自然SVIs审核中很难被体验到。同时，由于自然SVI摄像角度的限制，很难避免在同一地点不同视角的多个自然SVI所对应的不同感知评价结果。此外，由于深度神经网络模型的工作机制不透明，普通城市规划师和设计师无法了解计算机的内部决策过程，增加了建立信任和促进计算机模型输出的难度，特别是在面对涉及主观感知的任务时，如视觉步行能力，本身就很难解释和验证（Guidotti, Monreale, Ruggieri, Turini, et al., 2018; Ibrahim et al., 2019）。

In recent years, computer-aided auditing methods based on natural SVIs have emerged and are capable of objectively auditing a large number of walkability-related streetscape elements (Blečić et al., 2018), mitigating the shortcomings of previous manual evaluations with insufficient sample size and making it easy to apply the methods for comparisons across cities (Li et al., 2020). However, these methods have gaps in capturing and visually revealing real on-site walkability perceptions (Kim & Lee, 2022). For example, some perceptions that require a sense of space and similar levels of realism such as human scale, enclosures are hard to be experienced on browser-based auditing of natural SVIs. Meanwhile, due to the limitation of natural SVI camera angles, it is difficult to avoid different perceptual evaluation results corresponding to multiple natural SVIs with different perspectives at the same location. In addition, due to the opaque working mechanism of deep neural network models, ordinary urban planners and designers do not have access to the computer's internal process for making decisions, increasing the difficulty of building trust and promoting the computer model's output, especially when faced with tasks involving subjective perceptions such as visual walkability that are inherently difficult to interpret and verify (Guidotti et al., 2018; Ibrahim et al., 2019).

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Introduction

虚拟现实（VR）技术和基于深度卷积神经网络（DCNN）的深度学习算法克服了以往方法的局限性，在视觉步行感知研究中显示出巨大的潜力。**通过头戴式VR设备沉浸在由360度SVI组成的街道环境中，成本更低，其可行性和有效性接近于现场感知审计**（Lee & Kim, 2021; Kim & Lee, 2022）。**基于DCNN的图像分类可以基于全景SVI的深层特征大规模测量、分类和预测VWP**（Hu等人，2020），**语义分割算法可以用于批量分析SVI的元素份额**（Yin & Wang，2016），**这对于量化建筑环境和VWP之间的关系是非常必要的**（Y. Li 等人，2022）。**可解释的人工智能为VWP指标的设计者和计算机辅助决策模型提供了一个接口，这有助于我们理解、学习和验证VWP测量模型的决策过程**（Min等人，2020）。

Virtual reality (VR) technologies and deep convolutional neural network (DCNN)-based deep learning algorithms overcome the limitations of previous approaches and show great potential in visual walkability perception studies. Immersion in a street environment consisting of 360-degree SVIs through a head-mounted VR device is more cost effective and has feasibility and effectiveness close to that of on-site perception audits (Kim & Lee, 2022; Lee & Kim, 2021). DCNN-based image classification can measure, classify, and predict VWP based on the deep features of panoramic SVIs on a large scale (Hu et al., 2020), and a semantic segmentation algorithm can be used for batch analysis of the elemental share of SVIs (Yin & Wang, 2016), which is necessary for quantifying the relationship between the built environment and VWP (Li et al., 2022). Interpretable artificial intelligence provides an interface between designers and computer-aided decision models for VWP metrics, which helps us to understand, learn, and validate the decision process of VWP measurement models (Min et al., 2020).

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Introduction

1.描述课题背景

对某个领域现在是什么情况，先从大面说起

开头不要写与主题无关的字句

2.为什么需要进一步研究

Research gap

研究意义，存在的问题

文献综述(简短)，尽量句句有引用

3.做了什么

本文是如何进一步深入研究的

Research objectives, Research contribution

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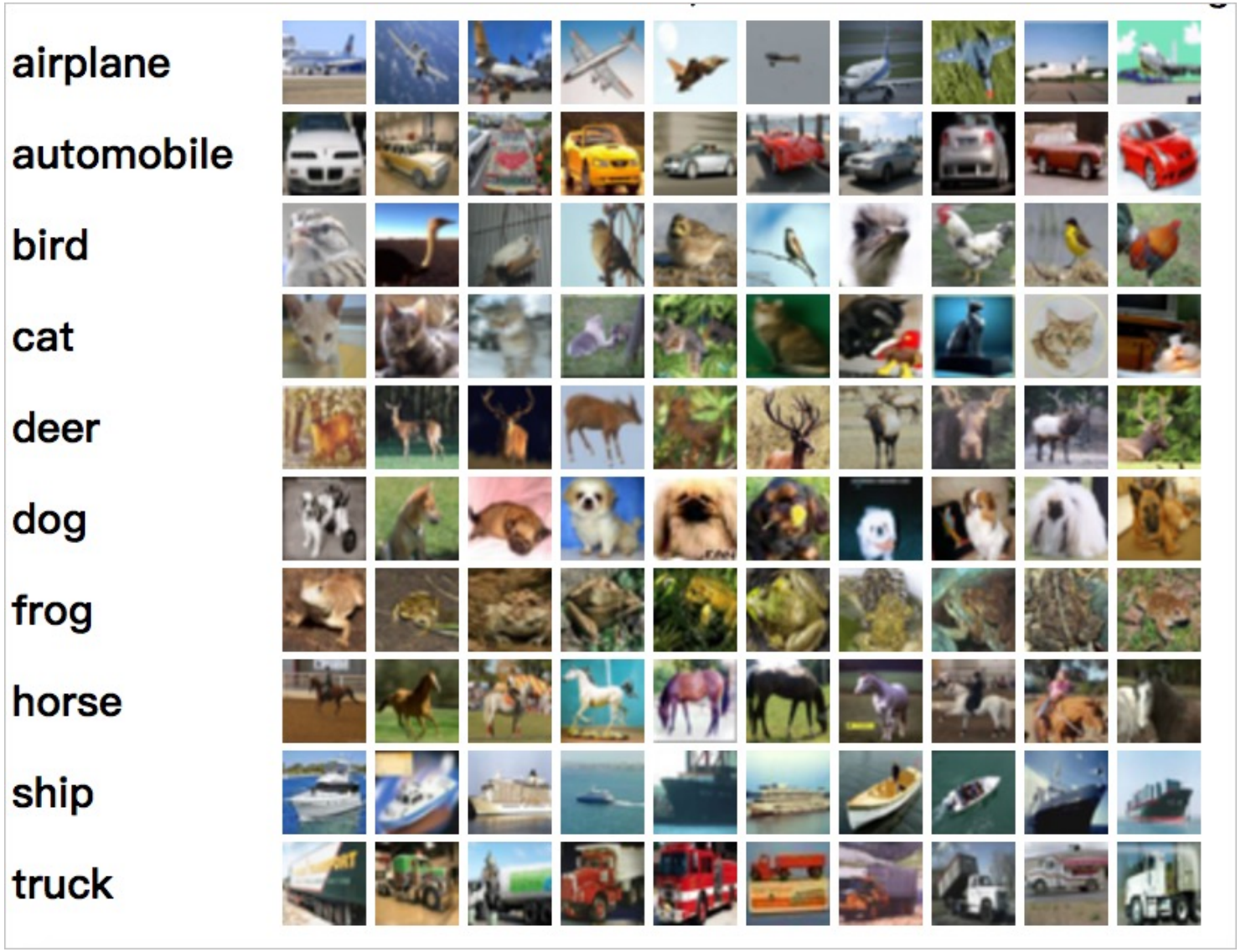
图像分类 image classification



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图像分类 image classification

- **Evaluation of perceived Walkability of Urban Streets (walking willingness scoring)**

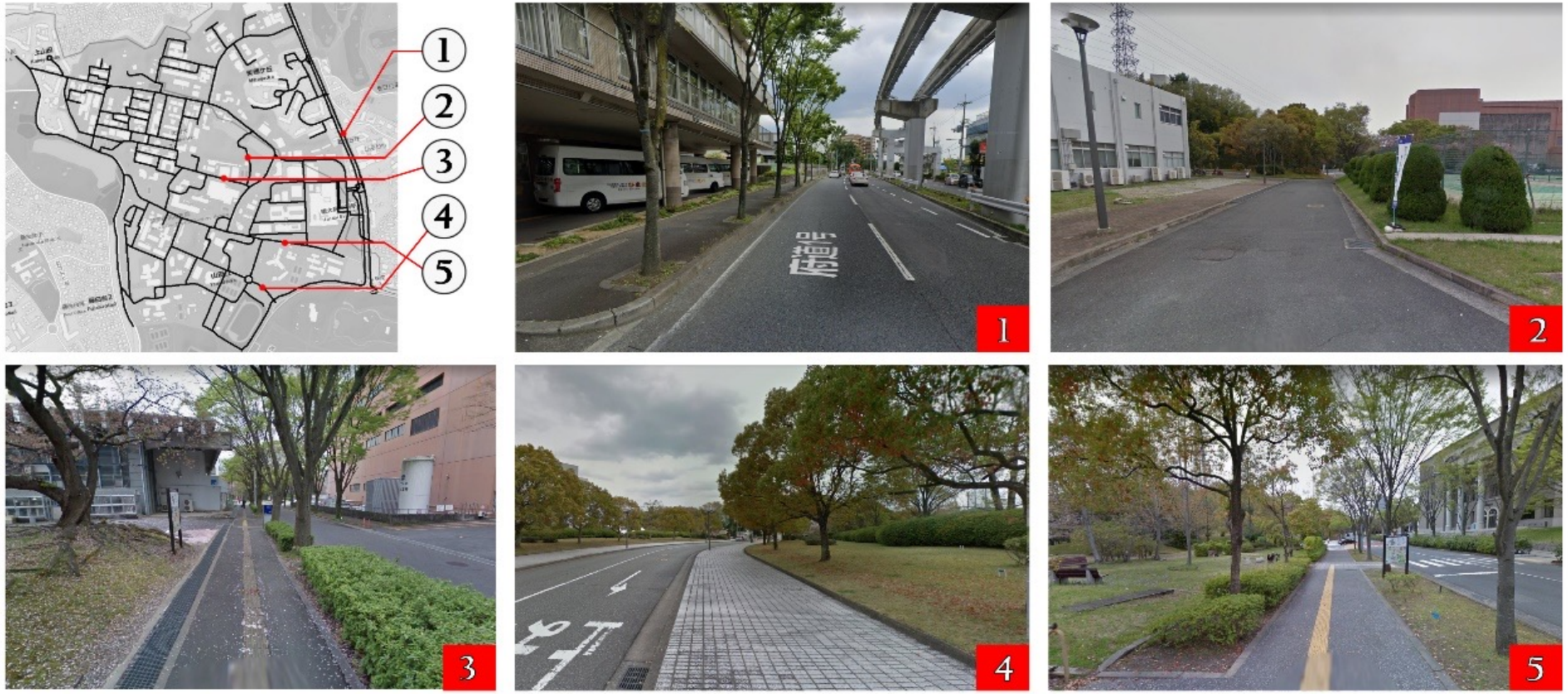

Figure Street-view images with walking willingness scores ranging from 1 to 5.

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语义分割 semantic segmentation

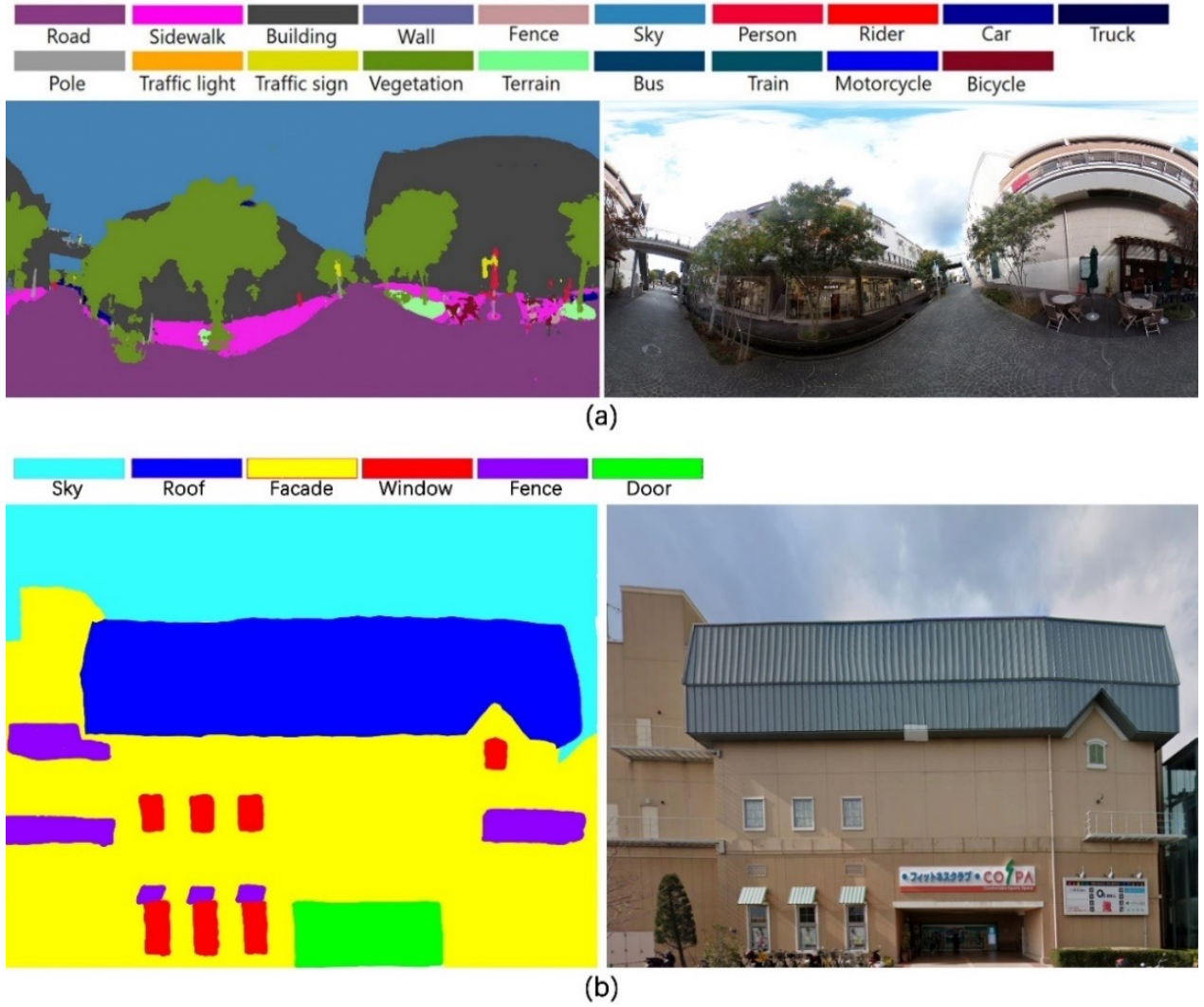

Figure Segmentation testing samples for (a) Deeplab-v3+ and (b) WEEK 3-Facade parsing

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可解释人工智能 interpretable artificial intelligence

Grad-CAM for "Cat"

Grad-CAM for "Dog"

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可解释人工智能 interpretable artificial intelligence

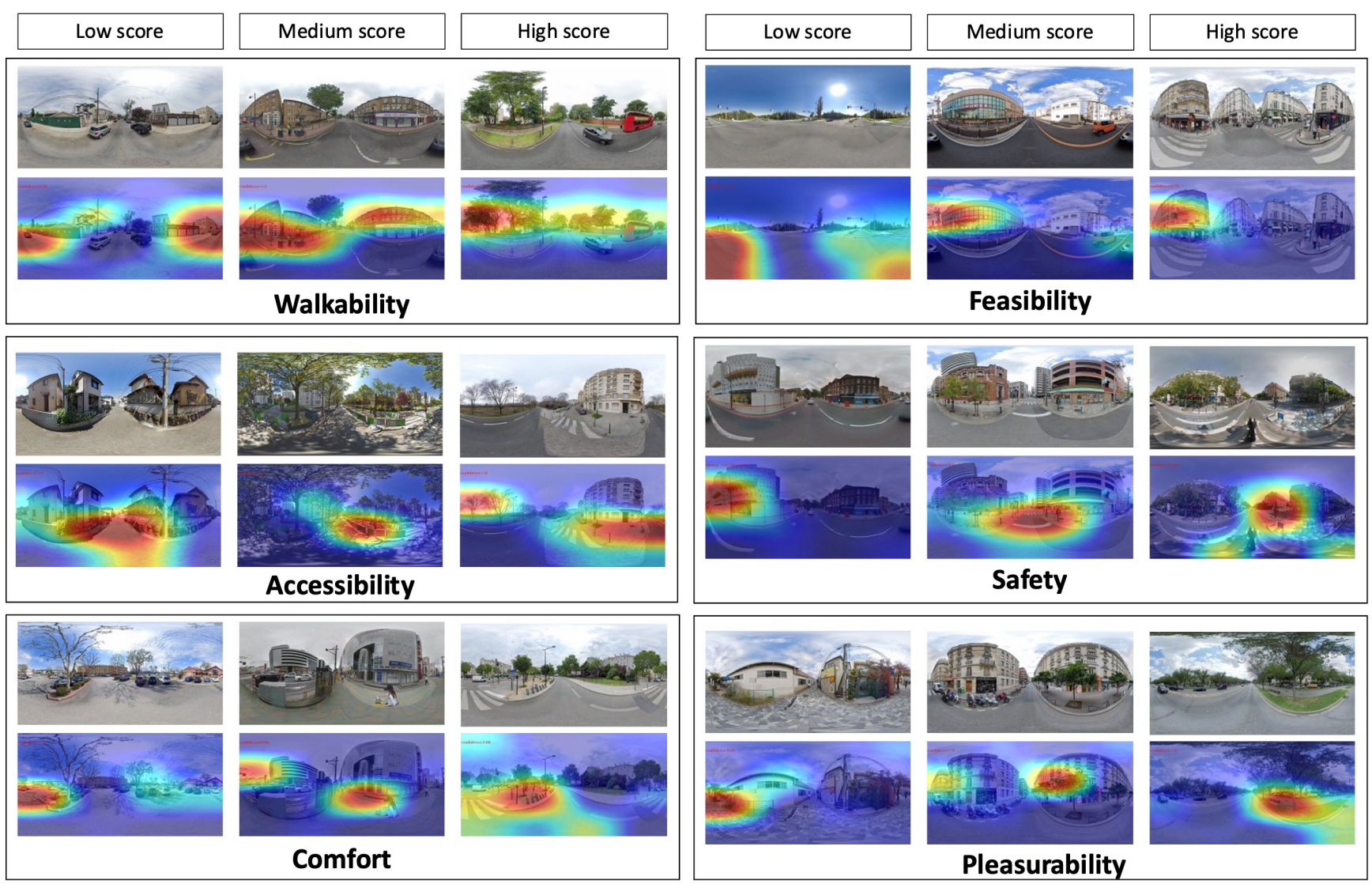

Figure Examples of Grad-CAM results for six-category VWP classification.

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在本研究中，我们构建了一个数据驱动的深度学习框架，用于基于VR的VWP测量，并采用全景SVIs。我们的研究目标是：（1）提出一种基于VR的成对比较方法，用于VWP的评分，分为六个类别，即可行走性、可行性、可达性、安全性、舒适性和愉悦性；（2）用定制的数据集设计一个VWP分类深度多任务学习（VWPCL）模型；(3) 使用逐步多元线性回归模型，从宏观角度分析物体比例与全景SVIs语义分割得到的VWP分数之间的关系；(4) 从微观角度使用可解释的深度学习将有助于VWP评价的物体可视化；以及(5) 验证我们的VWPCL模型的有效性及其可解释的深度学习结果。

In the present study, a data-driven deep learning framework is constructed for VR-based VWP measurement with panoramic SVIs. Our research objectives are to (1) propose a VR-based pairwise comparison approach for VWP scoring in six categories, namely, walkable, feasibility, accessibility, safety, comfort, and pleasurability; (2) design a VWP classification deep multitask learning (VWPCL) model with a tailored dataset; (3) use a stepwise multiple linear-regression model to analyze the relationship between object ratios and VWP scores obtained by semantic segmentation of panoramic SVIs from a macroscale perspective; (4) visualize the objects contributing to the VWP evaluation using interpretable deep learning from a microscale perspective; and (5) validate the effectiveness of our VWPCL model and its interpretable deep learning results.

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我们在本文中描述的主要贡献可以概括为以下几点：

- 提出了一个基于VR全景的深度学习框架用于VWP测量。这是一种基于全景SVI大数据的观察、感知、审核和理解街道建筑环境特征和主观视觉感知的新范式。与基于浏览器的评价相比，沉浸式的VR视觉化帮助评分者做出接近真实现场感知的评价。此外，基于VR全景的审核还解决了基于同一地点不同视图的自然SVI的评分偏差，结果更加一致。
- 训练了一个基于DCNN的VWPCL模型来分类和预测VMP评价结果，并与现场审核结果进行了验证。此外，还建立了一个量身定做的图像数据集，用于训练VMP分类器。
- 使用多元线性回归探讨了街道视觉元素和每个具体的视觉可行走性感知之间的关联。此外，我们应用Grad-CAM模型来可视化每个VWP类别的突出区域，并评估了调查问卷中确定的贡献性视觉元素与深度学习模型的激活热图的一致性。总的来说，这两种方法为观察和解释VWP与街道建筑环境元素之间的关系提供了宏观和微观的视角。

Our main contributions described in this paper can be summarized as follows:

- A VR panoramic-based deep learning framework for VWP measurement was proposed. This is a new paradigm for observing, perceiving, auditing, and understanding the street built environment features and subjective visual perceptions based on the big data of panoramic SVIs. Compared to browser-based evaluation, immersive VR visualization helped raters make evaluations that were close to their real on-site perceptions. In addition, the VR panorama-based audit also solved the scoring bias of the natural SVIs based on different views of the same location with more consistent results.
- A VWPCL model based on DCNN was trained to classify and predict VMP evaluation results and verified with on-site auditing results. Furthermore, a tailored image dataset for training VMP classifiers was built.
- The association between the street visual elements and each specific visual walkability perception was explored using multiple linear regression. In addition, we applied a Grad-CAM model to visualize the saliency areas of each VWP category and evaluated the consistency of the contributing visual elements identified in the questionnaire with the activation heat map of the deep learning model. Overall, these two methods provide both macro- and micro-scale perspectives for observing and interpreting the relationship between VWP and the elements of a street built environment.

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The rest of this manuscript is organized as follows. Section 2 reviews related work and Section 3 explains the framework and steps of our research method. Section 4 describes the experiment and the results of our proposed methods and method verification. Section 5 summarizes our findings and contributions and discusses the limitations and future work, and Section 6 provides concluding remarks.

- 本稿件的其余部分组织如下。第2节回顾了相关工作，第3节解释了我们研究方法的框架和步骤。第4节描述了实验和我们提出的方法和方法验证的结果。第5节总结了我们的研究结果和贡献，并讨论了局限性和未来的工作，第6节提供了结论意见。

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