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A brief evaluation regarding the use of street view images for urban studies

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Abstract

Street view images (SVIs) have the great potential to obtain essential data for assessing the urban street's environmental conditions. SVI enables visualization of the urban landscape through a human-centric view. Therefore, some vertical detail about streets not detected by traditional remote sensing methods can be easily obtained and analyzed. street view images can be available freely through several web services. In addition, with the advances in digital image analysis and deep learning techniques, the results from SVI analysis can be improved. This new data source has been used in many types of urban studies in recent years. This study highlights the potential of SVIs as a new data tool for urban planning by presenting recent street-level urban studies based on SVIs analysis.

Introduction

Today, economic, social, and cultural activities have become increasingly complex due to globalization trends, technological advancements, and widespread communication options [1]. In this regard, the nature of the needs in the cities has gradually changed. With the parallel of this transformation in urban areas, spatial planning requires a comprehensive land management approach addressing social-economic needs, healthy lifestyles, protecting natural resources, and energy issues to design the urban environment.

Thanks to technological developments, it is now possible to use various data sources for geo-information science [2]. Unmanned aerial vehicle (UAV) techniques, satellite images, and digital globes providing street view perception are common data collection techniques in urban studies. Despite the advantages of UAV and satellite data acquisition techniques, they have some constraints in obtaining vertical details of urban areas with sufficient accuracy. In this case, Street view images can be effectively used in vertical urban research to understand street spatial characteristics and identify urban features.

Street view images can provide crucial information for understanding urban conditions. SVI allows the visualization of urban landscapes from a human-centered perspective. Recently, street view images can be accessed freely through several web services such as Google, Microsoft, Baidu, and Tencent [3]. With the enhancement in computer vision techniques and deep-learning strategies, the visual perception of streets provides more meaningful information for supporting urban planning and land policy making.

This study aims to show the potential of SVIs as a new data tool for street-level urban studies. This study also aims to classify urban studies based on SVIs to create a comprehensive overview.

Street View Images for Urban Studies

This new data source has become a central part of many types of research. These studies have primarily focused on assessing visual space qualities of the urban streets [3-8], detecting trees and other types of plants in urban areas [1-13], visualizing the climatic conditions and air pollution for a specific time [14-16], walkability [17,18], and obtaining building-level information [4, 19-21].

Virtual space qualities of urban streets

Virtual quality is a function of the connection between landscape elements and individual residence perception [9]. The visual perception of built-up urban areas has a strong influence on the quality of urban residents' life [3]. Therefore, developed countries consider designing and analyzing visual perception elements in urban areas. Many studies have focused on developing visual perception parameters to analyze urban environment quality. The visual quality of cities can be described by different urban features such as greenery, pedestrian space, motorization, traffic density, cleanliness, and sky openness. In recent years, SVIs have become an effective tool for measuring visual perception metrics.

Chang et al. revealed the potential of using Tencent Street View images to automatically analyzed the visual perception of the Jianye District of Nanjing City in China according to visual entropy, green view index, and sky-openness index [3]. Gong et al. calculated the main view factors describing the urban thermal environment in the high-density streets of Hong Kong based on Google Street View (GSV) images and a deep learning feature extraction algorithm [4]. Ye et al. analyzed the perceptual-based visual quality of streets, including the building frontage, greenery, sky view, pedestrian space, motorization, and diversity, using screenshots from Baidu Street View and a machine learning algorithm [6].

These mentioned studies show that SVIs obtained through different online services can be utilized for urban street quality analyses. In addition, these kinds of analyses can be easily automated with the help of a deep-learning approach,

Detecting trees and other plants in urban areas

The existence of street greenery has crucial effects on mitigating climate change, reducing urban pollution, protecting urban resources, and improving human health [10,11]. Recent studies have emphasized the benefits of SVIs as a new data source for determining the characteristics of urban trees.

Seiferling et al. tested their model to obtain vertical information, that cannot be detected from traditional long-range remote sensing methods, on the urban tree cover from the perspective of pedestrians by using GSV images [11]. In another study, Li and Yao presented a 3D system for determining tree inventory with geographic locations in Hong Kong based on GSV panorama images by combining a deep learning approach [12]. Ringland et al. showed the availability of using GSV images and RetinaNet, an object-detection method, to map plant species widely grown in home gardens facing the roads in Thailand [13].

According to these studies, SVIs can be a good choice for obtaining the spatial distribution of plant inventory in the cities. This information can be efficiently used in upper-scale planning.

Visualizing the climatic condition and air pollution for a specific time

SVIs may enable an analysis of urban meteorological conditions and air pollution levels in cities. The meteorological dynamics of cities can present the urban population and environment interaction. The relation between street visual metrics and air pollution [14] can be analyzed. Furthermore, weather conditions can be extracted for a specific period using street-view images [15]. It should be noted that the quality of SVIs is an important issue that can adversely affect experiment results.

Walkability

Walkable streets contribute the social life and environment-friendly mobility. SVIs are popular data sources for walkability analysis. SVIs have recently improved the walkability analysis from the street scale to the large scale by combining sensor technology and digitization [17]. For instance, Yin et al. conducted a study to detect and count pedestrians from GSV images using a deep-learning method [18]. Therefore, pedestrian volume and traffic conditions [18] can be analyzed at the street level.

Obtaining building-level information

Many studies have asserted the advantages of using SVIs for mapping places [19], classifying building functions [20,21], and identifying landscape features at the street level [4]. Li et al. achieved classifying residential and non-residential buildings using GSV images [20]. This study used three image feature descriptors to represent GSV images of different buildings [20]. Zhang et al. develop an approach to analyze the relationship between building dominant color and building functions including residential, public services, commercial services, and other facilities.

Conclusion

These academic studies indicate that utilizing SVIs to investigate the interaction between humans and urban environments yields comprehensive and accurate results. Accessible SVIs can be easily used for understanding the dynamics of the outdoor environment on a street-level scale for urban areas, it is seen that the machine learning techniques used in these studies improve image analysis performance as well. Some critical information describing buildings and their functions can be obtained through the SVIs without field survey data collection and manual interpreting. SVIs provide an opportunity to obtain meaningful and comprehensive data for urban planning.

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