Urban Environment Evaluation and Analysis Based on Street View Image

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Abstract. The real and intuitive reconstruction of the city street scene can not only give the viewer an immersive feeling, but also serve as a way to display information. As a mass data, it also provides unique decision-making ideas for recording phenomena, discovering rules and predicting results. This paper proposes a green visual rate to measure the green apparent area of urban street trees. For complex urban street landscapes, the green apparent area index can well reflect the visualization degree of green area of street trees and urban environment under street scenes. Research to Skesfehervar, Hungary as an example, it carried out the street tree green apparent area calculation model test research in different characteristics of road sections, different street scenes under the authenticity and adaptability.

Keywords: The city street scene, Authenticity and adaptability

1. Introduction
A city is a complex ecosystem and a living organism in a sense. It is composed of natural elements such as water, earth, air, generation and heat and artificial elements such as roads and buildings, constantly generating the exchange of materials, energy and information. As the most important habitat for human beings, more than 50% of the world's population already lives in cities. Urbanization is an inevitable trend of social development. Whether urban residents can conveniently and equally enjoy the functions and services of urban green space is an important index to evaluate the urban environmental sustainability. It is one of the three goals of environmental improvement, economic development and social equality that a city should achieve. It is also the only way and an important principle for urban development.

As a new way of map service, city street view has been given high expectation and wide attention since its launch. The most famous Street View service is Google's Google Street View service. Google Street View is a feature embedded in Google Maps and Google Earth that provides street view cars with 360° horizontal and 180° vertical street photos. The current research based on street view data mainly focuses on two topics. One of them is to highlight the "image" attribute of street view data, digitize it, and use image processing algorithm to build a new data layer from the extracted information. These algorithms borrow methods from areas such as computer vision and machine learning, extracting features from street Numbers, business names, traffic signs, speed limit signs and other points of interest. The second is to highlight the "photo" attribute of street view data, which is used as an inspection basis and evaluation method in human geography, landscape planning and other
fields. By mining data from tens of thousands of street scenes from different cities, the Team at Carnegie Mellon University has extracted the most iconic visual elements of Paris, that is, Windows, balconies and streetlights. Rousselet, aided by Google street view images, obtained the distribution of the species in the French political heartland by visually identifying the nests of larvae in trees, and demonstrated the power of the Google database in providing real-time data.

This study was based on the present livability demand increasingly strong background, in view of the present our country still lack can accurately describe the street level indicators of spatial distribution of green space, and the evaluation index model of visual quality difference of urban residents enjoying street level green landscape during their travels, research by pedestrians visual intuitive feeling as a starting point, based on street view data, in-depth analysis research, trees and green area calculation model under the different characteristics of road and street scenes of authenticity and adaptability.

2. Street View Data Preprocessing

Google street view cars are equipped with imaging sensors and GPS locators that can provide street-level images of different locations in the city. Each available GSV Image can be called in the form of an HTTP URL via the Google Street View Image API service provided by Google maps. It only need provide an HTTP URL address, such as, https://maps.googleapis.com/maps/api/streetview?parameters[1].

This API returns the street View panorama JPG address. By giving parameters such as desired geographic position, shooting orientation and pitching Angle, the user obtains a static GSV image of any position, direction and Angle. Images are saved in PNG, GIF, or JPG formats. A sample URL requesting a GSV static image and the corresponding GSV image (Figure 1) are shown below.

![Figure 1 Example street view](image-url)

The configurable parameters specified by the API mainly include location, size, heading, FOV and pitch. The meanings of each parameter are as follows[2]:

- **Location parameter** is used to specify the geographic coordinates at which the GSV image is to be obtained, either as a text string (such as Chagrin Falls, OH) or as a latitude and longitude value (such as 40.722578, 73.987187), and the GSV API will capture the panorama closest to that Location.

- **Size parameter** is used to specify the output Size of the image in pixels, and gives the Size of the output image in the form of width × height. For example, size = 600x400 will return an image 600 pixels wide and 400 pixels high.

- **FOV parameter** is used to determine the field of view Angle of the image. The default value is 90. The field of view is expressed in degrees and the maximum allowed is 120. When working with fixed-size viewports, the field of view essentially represents zoom, just like a street View image that is set in size. The smaller the number, the higher the zoom level.

- **Heading parameter** indicates the camera's shooting orientation and ranges from 0 to 360. Both 0 and 360 represent north, 90 represents east, 180 represents south, and 270 represents west.

- **Pitch parameter** is used to specify the pitch angle of the camera relative to the vehicle in street view. The default value is 0, i.e., head-up. A positive value indicates the camera tilts upward (90 degrees is
positive), and a negative value indicates the camera tilts downward.

3. Information Extraction

3.1 Street View Image Segmentation

Image segmentation is a key step in the process of object-oriented image classification. The quality of the segmentation results will have a direct impact on the subsequent feature extraction and image classification. Watershed segmentation is a mature image segmentation algorithm in computer image processing. The watershed segmentation algorithm regards the gray image as an elevation model, and the gray value of each pixel in the image represents the altitude of the point. Each local minimum value and its affected area are called the catchment basin, and the boundary of the catchment basin is the watershed. In the image segmentation, the image is converted into a marker image, in which all the points belonging to the same water basin are given the same marker, and a special marker is used to identify the points on the watershed. However, due to the sensitivity to noise, the traditional watershed algorithm usually has a serious "over-segmentation" phenomenon[3,4].

The segmentation method used in this paper is the dynamic threshold labeled watershed segmentation algorithm proposed by Li Yanhua. The main idea of this algorithm is to control the over-segmentation phenomenon of traditional watershed transformation by adding marker points in the gradient map. The specific steps are as follows:(1) Firstly, gradient images are obtained based on Sobel operator, and the global optimal gradient threshold is obtained by histogram statistics of gradient images. (2) Gradient trend map can be obtained through Gaussian low-pass filtering of gradient image to realize dynamic marking; (3) After obtaining the marked area of gradient image, watershed algorithm is adopted to realize the final segmentation of the image. In the experiment, the accumulative probability and threshold adjustment coefficient will be set according to the street scene characteristics and the relationship between ground objects and the optimal threshold parameter will be obtained through manual repeated testing under the premise of ensuring the image is fully segmented.

3.2 Feature Information Extraction

After image segmentation and processing, the objects contain a large number of features, such as color, shape, texture, spatial position relation and upper and lower relation, which can be used to assist classification decision. The quantization group of key features can effectively improve classification accuracy and avoid the phenomenon of "foreign body in the same spectrum, same object in different spectrum". The ground objects in the street scene have distinct spatial layout characteristics, which are embodied in: (1) The ground objects in the street scene have a relatively fixed category, usually including: road, other (vehicles, cyclists, pedestrians), grass, street trees, buildings, sky; (2) The ground objects in the street scene include: road, other (vehicles, cyclists, pedestrians), grass, street trees, buildings, sky. (2) the street view feature showed a bottom-up sequence characteristics, can be described as: road often appear in the bottom of the image, obstacles randomly appear on the road, the road on both sides may have grass distribution, interval trees is arranged on the road boundary, is obscured behind the building, the top usually appears in the sky as a background image.

There are also some connections and differences in the performance of the ground objects in the street scene on each feature vector. By comparing the values of spectrum, texture and location features of road, building, grassland, tree canopy and sky, we found that: (1) the spectral brightness value of road trees in green bands is relatively high, and they are generally easy to be distinguished from road, building and sky. (2) The spectral characteristics of roadside trees and grassland are similar, so the spatial position relation should be used for further classification; (3) It is also difficult to identify the spectral features of street trees and other interferences that are also green (such as green traffic signs and storefront signs). However, as the texture details inside the tree canopy are more obvious, texture information can be used to distinguish them.

Based on the above understanding of street scenes, the feature vectors used in the classification of
street scenes in this paper include: (1) Six spectral feature vectors, including the gray mean and standard deviation of R, G and B bands; (2) Two texture feature vectors, including angular second moment and entropy; (3) One position eigenvector, namely, the normalized average height position.

3.3 Street View Image Classification

In this paper, the nearest neighbor classification method is adopted to realize the object-oriented supervised classification of street view images. Firstly, the spectral information, texture information and position information of the segmented objects were calculated statistically according to the 9 feature vectors selected in the feature extraction steps. Then, the typical regions with good homogeneity of the objects were selected to complete the sample training. Finally, the classification of the segmented images was completed based on the nearest neighbor classification. Figure 2 shows the street view classification results for several locations in the study area. The results show that the shape of the classified patches is regular and complete, indicating that the classification of ground objects obtained after classification is consistent with the real scene. The random sample test shows that the classification accuracy of the canopy of street trees is better than 90%.

4. Green Visibility Calculation

In the traditional evaluation of urban green landscape, indicators such as "green rate" and "green area per capita" are mostly used. These indicators are helpful to grasp the quantity characteristics of urban green space on the whole, but they cannot consider the fairness of urban green space resource utilization and the rationality of layout from the perspective of pedestrians.

Based on the image classification results, the calculation of "green visibility" is obtained by counting the proportion of the number of pixels representing the street trees in the total pixels of the whole image in the classification results of each street view. The "green apparent rate" at the locations of each sampling point is the arithmetic mean of the sum of single green apparent rate in N directions. Table 1. shows the calculation formula of road tree green visibility under the four lens parameter Settings.

| Camera Settings | Green apparent rate calculation formula |
|-----------------|----------------------------------------|
| Parameter1      | $GVI_1 = \frac{\sum_{i=1}^{4} Area_i}{\sum_{i=1}^{4} Area_i}$ |
| Parameter2      | $GVI_2 = \frac{\sum_{i=1}^{4} \sum_{j=1}^{2} Area_{ij}}{\sum_{i=1}^{4} \sum_{j=1}^{2} Area_{ij}}$ (FOV = 60) |
| Parameter3      | $GVI_3 = \frac{\sum_{i=1}^{4} \sum_{j=1}^{2} Area_{ij}}{\sum_{i=1}^{4} \sum_{j=1}^{2} Area_{ij}}$ (FOV = 120) |
| Parameter4      | $GVI_4 = \frac{\sum_{i=1}^{6} \sum_{j=1}^{2} Area_{ij}}{\sum_{i=1}^{6} \sum_{j=1}^{2} Area_{ij}}$ |

Figure 2 Street image classification results
It shows the distribution of the results of green visual acuity calculation in the study area under one of the lens parameter settings in figure 3.

![Figure 3 Green visual acuity calculation results](image)

5. Conclusion
In the information extraction section of the road tree, the principle and application of the watershed segmentation algorithm based on dynamic threshold marker are described. The results show that the extraction rate of the tree based on the object-oriented classification algorithm reaches 90%. Finally, to Hungary Skesfehervar as a research area, through the weighted sum of the way to calculate the street trees green visual distribution.

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