The mapping of historical streets on social media: a case study based on image recognition and semantic recognition

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Abstract: In the age of social media, the interaction of online and offline activities has produced a more diverse form of interaction between people and space. Weibo is the largest social media in China, where users share their insights by uploading photos and text. Historical streets carry important urban cultural imprint while its protection is facing the problem of enhancing attractiveness under the rapidly urban development. This study collected the Baidu Street View image and geo-tag Weibo photo of Hengfu historic conservation. Images were recognized through the machine learning algorithm, in order to realize the accurate measurement of the image elements. Building and greenery were the focus of attention of the crowd, and some streets have improved people's contact with greening through the design of vertical greening. Second, we combined the campaign of the hot events such as ' Leave fallen leaves' in social media, with the semantic recognition of the text of users ' Weibo. This paper analyze how the streets interacted with the online crowd with the help of social media, and analyze why some streets are more attractive while others lack attention and record, and put forward suggestions for urban design of historical street in future.

Keywords: social media, machine learning, historical street, visible greenery

Introduction

The rapid spread of information has greatly affected the behavior and needs of people, thus reconstructing the needs of people for physical space. For example, the appearance of Amazon and other online retailers make thread to normal bookstores. Some independent bookstores have been revitalized by the use of social media campaigns to strengthen their ties with the community (Ryan, 2017). Readers share the bookstores they've been to and advised book on Instagram. Independent bookstores host many events to bring people together and provide more personal customer experience.

As an important component of urban space, streets also face the same situation. Video games, animation and internet reduce people's interest in outdoor activities. It's important to realize people's attitude about urban space through traditional field study and social media. For urban designers, it's reasonable to connect the advantages of social media and physical street space. The quality of street

space affects the experience from pedestrian, the vitality of public activities, and even the shaping of urban characteristic (Jacobs,1961).

The use of social media in design is accompanied by a shift from top-down to bottom-up perspectives. With the help of new technologies, we could better measure urban space and evaluation from human-scale (Ye Y,2018;). Sina Weibo(microblog) is the largest social media platform in China, with 411 million monthly active users in 2018. Users can sign the location when they reach the urban physical environment and publish relevant text and pictures to describe the activity experience. As a kind of Location Based Service data, Weibo data is widely used in social activity, tourism evaluation and crowd flow (Jiang, W,2015; Wu, L,2014; Yan, L,2018;). Yan analyzes the relationship between Weibo check-in data and air pollution. It's found that air pollution has a negative impact on urban activities. Weibo pictures based on street position also reflect the arrival of users and a record of urban life, and a small number of studies use it to research about urban image, urban memory and other topics.

Literature review

The use of social media in urban planning and urban design

Research on social media and planning focus on the distribution of urban activities, public participation, urban heritage conservation, and so on. Social media contain a wide range of feelings and memories related to the urban past (Van,2019). Storytelling and mapping could be used to invited citizens to join in historical area conservation, providing opportunities to understanding urban history and big events.

In China, social media enable planners to focus on a wider range of information and to communicate planning information (Sun,2013). Sun host a talk about change from AutoCAD to Sina Weibo. There was an example that one planner protested about unreasonable demolition of historical buildings through Weibo and caused a lot of retweets from planners to citizens. Traditional media also reported this situation and finally the government canceled the demolition and promised to protect those buildings. Although it's difficult to deeply discuss professional knowledge though social media, we can use it to collect voice from citizens and present planning views.

Image recognition and urban design

In recent years, with the development of new urban science (Michael,2013), image recognition, machine learning and other new technologies have been applied to urban studies. Image recognition is one kind of new technology that use Convolution Neural Network Algorithm to extract image elements. At Urban scale, researchers used a large number of images from interaction website to social media. Palomares studies the distribution law of tourist hotspot in 8 major cities in Europe based on Panoramio Pictures (Garciapalomares,2015). There was some interesting things like connection between urban image and pictures which people post in the website (Liu,2016).

At street scale, Street View can be used to accurately measure the morphological and factor of urban space（Yu,2018）. Some map website like Baidu and Google have collected multi-year streetscape photos then could be used to study the quality and spatial change of streets in Beijing (Tang,2018). With image recognition, street view could accurately measure the city environment space, refines the related streets streetscape research to improve street quality.

Table 1. Urban Study used Image recognition

Research aspect	***Urban scale***		***Street scale***	
	Urban Image	Tourism	Quality of street	Street Greenery
Analysis point	Image features, architectural colors	Tourism agglomeration and urban spatial perception	Time-phase change, physical and interface features	Visible street greenery, accessed street greenery
Data source	Image interaction website (Flickr)	Image interaction website, social media	Street View	Street View
Typical Research	Liu selects the photos from Panoramio and Flickr, using the deep learning technique to identify and classify the photo contents (Liu,2016).	Based on Panoramio Pictures, Palomares studies the distribution law of tourist hotspot in 8 major cities in Europe. The tourist route and activity space of local residents are analyzed (Garciapalomares,2015).	Based on multi-year streetscape photos, Tang studies the quality and spatial changes of streets in Beijing (Tang,2018).	Li X uses Google Street View to measure the proportion of street greening, compared with the living environment of residents. (Li,2015).
Research features	Use a large number of open source image data and recognition technology. Compare the images of different cities horizontally.	Users take the upload photos spontaneously, and consider subjective feelings and objective vitality distribution	Because the streetscape images can be collected for many years, it is beneficial to the measure the quality and characteristics.	In-depth study of street Greenery, a street space element is perceived by residents in daily contact

Method

Research framework

As seen in Figure 1, to map the historical streets on social media, this study selects visible street features, recorded street features and people's recording about program 'Leave fallen leaves' as the major study objects. First, street networks of the area were collected from Open Street Map(OSM). This is for subsequent image collection and presentation on GIS. Baidu Street View(BSV) was collected through the Baidu API by Python. Second, we collected text and picture from Sina Weibo during August, November and December, 2018. Text posted during the Program period were analyzed through semantic recognition to find out what's the focus of people's expression about this programe.

Third, the measurement of visible and recorded street features were achieved by image recognition. We used TensorFlow, a neural network algorithm platform developed by Google and Cityscapes Training set, a datasets in driverless environments launched by Mercedes-Benz. Both BSV and pictures from Weibo were analyzed to get human-scale indicators which had rarely been studied before. Image recognition could classify the features such as greenery, sky, building, people, road, etc. We can find out which road or what features is more recorded by people. Finally, based on the analysis on the program 'Leave fallen leaves', this study figure out the hot words and organizers' reaction to social media views.

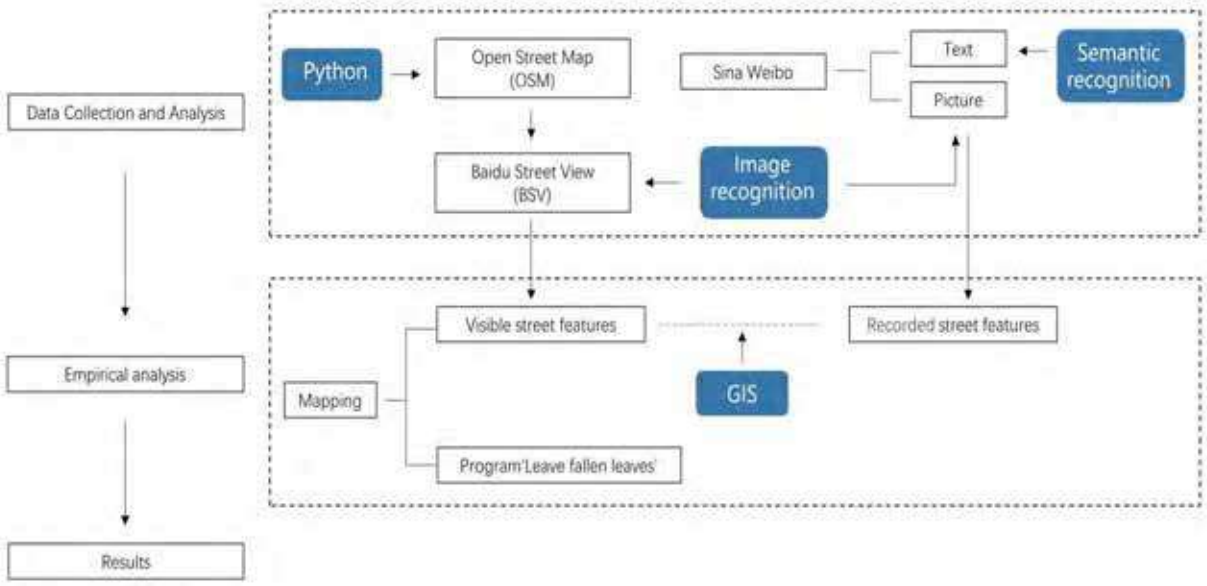

Figure 1. Research framework

Study area

For this study, we selected the Shanghai Hengfu historic conservation area, of around 7.75km^2, as the study area(Figure 2). It's the largest historical conservation area in Shanghai central urban area, with the highest number of style-protected roads. The consevation area formed its style in the first half of the 20th century, with 66 roads and a total length of 9.78km. The streets in the area have pleasant scale and embody the characteristics of modern space form and public activity place in Shanghai.

Figure 2. Shanghai Hengfu historic conservation area

Data collection and analysis

The measurement of street features started from the collection of Baidu Street View and Weibo pictures. The study was carried out in the winter of 2018 to collect 66 streets in the area (Figure 3), the total street length of 9.87km. The average sampling spacing is about 25 meters and a total of 4,159 sampling points are identified. The Baidu Streetscape API (http://api.map.baidu.com/pano) is called by Python via HTTP URL to obtain Street View images from the perspective of each sampling point. The study crawl a total of 4159 BSV images (image resolution of 512*256 pixels), covering all areas of the Hengfu historic conservation area.

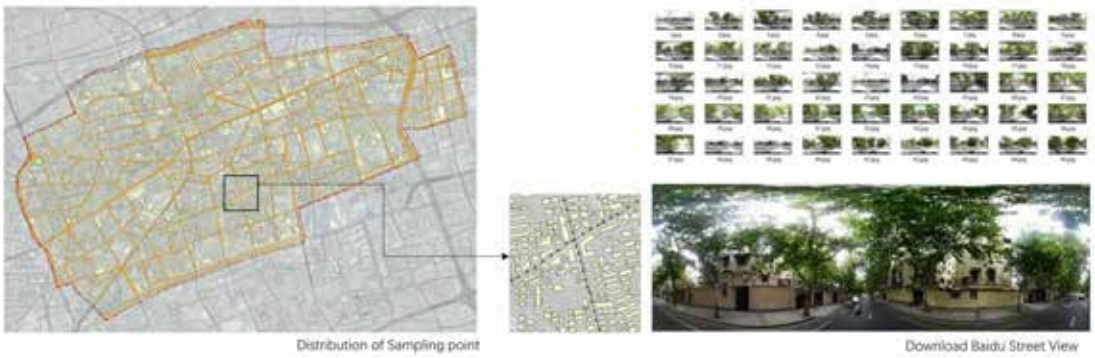

Figure 3. Baidu Street View Data collection

The neural network algorithm platform is developed by Google TensorFlow and Mercedes-Benz launched the Cityscapes training set, with the help of machine learning automatic image recognition. The Street View pictures are divided into roads, sidewalks, buildings, vegetation, skies and other elements(Figure 4.). The sampling point results are then based on the ArcGIS platform, through Spatial Join analysis to each streett, to achieve visual rendering of the results. Pictures from Weibo are also analysis by image recognition.

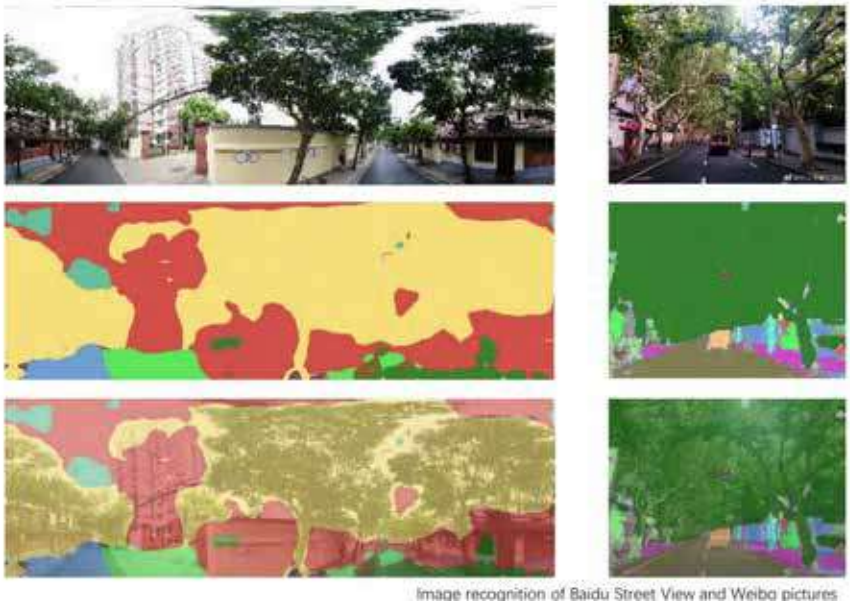

Figure 4. Image recognition of Baidu Street View and Weibo picture

After text was collected from Weibo, Semantic recognition could quantify feature words extracted from the text to represent the information. Social media is an effective window to observe human emotions. This study uses Jieba (https://github.com/fxsjy/jieba), the best Python Chinese word segmentation module.

Results

The vitality of different historical streets

This study collected a total of 878 photos from Hengfu historic conservation in August, of which 349 photos were collected from Rd.Wukang（Figure 5）. We filter the upload valid photos with street view, including portraits, building facades, streets views, road, etc., to reflect the user's attention to the street. It's reasonable to exclude those invalid photos including food, indoor, selfie, emoticon that do not reflect the street space. Style-protected roads collect more Weibo photos in quantity and density, indicating that people pay more attention to the streets and particular streets are more energetic. People focus on some historical buildings like Normandy Apartments as 66 photos are about Normandy Apartments of 349 photos collected based on Rd.Wukang

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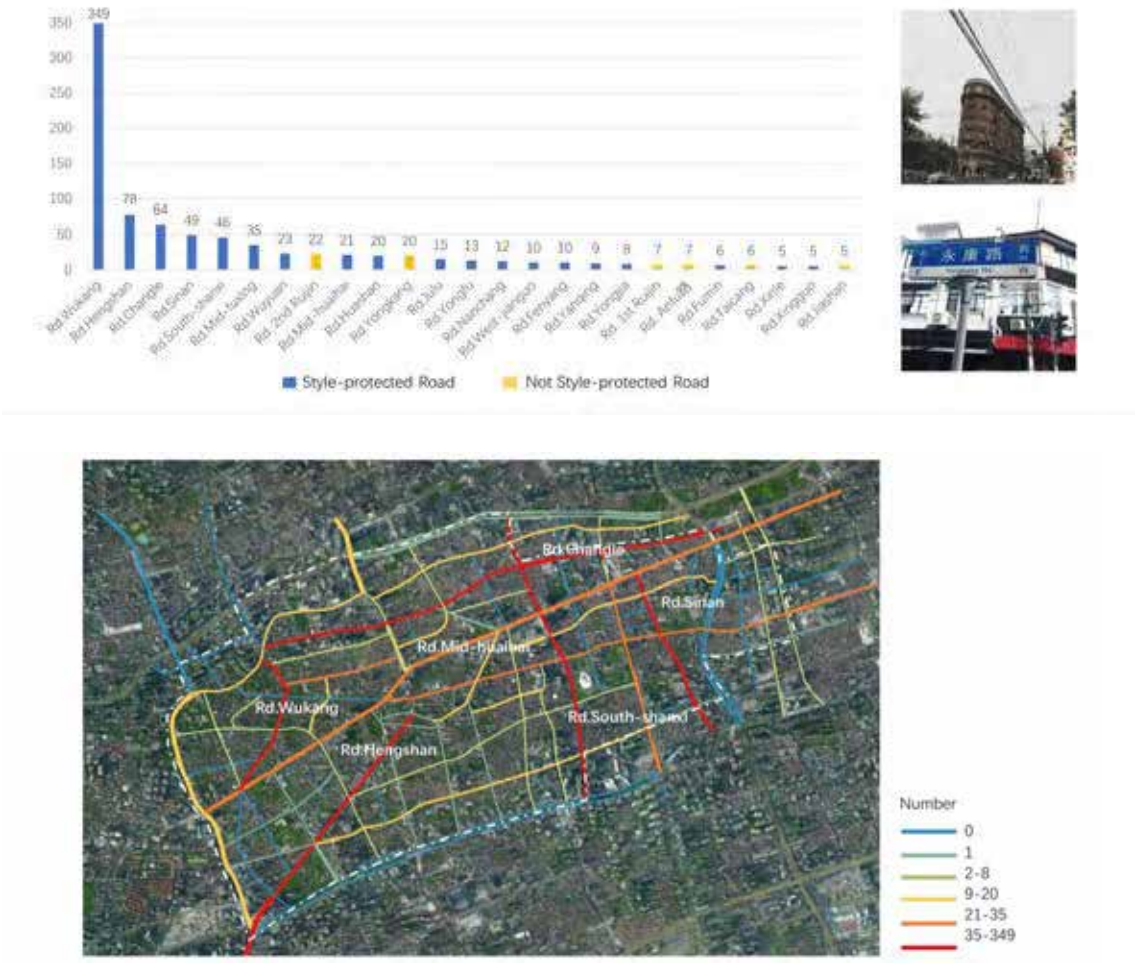

Figure5. The number of Photos uploaded on Weibo in Augest, 2018

The comparison of visible and recorded street features.

From the result in Table 2. It's obvious that in reality Greenery(57.3%) , Sky(21.5%) and Building(14.0%) are the main component of street views. We could find that Building(38.5%) , Greenery(28.8%) and Sky(4.9%) are the focus of attention of the crowd. As we all know, there are a lot of protected buildings and style-protected roads in this area. It's special cultural atmosphere attracts special shops and hot restaurants to open in this area. Many citizens and visitors enjoy going to Hengfu historical conservation area and taking pictures of some hot restaurants or historical buildings. Some microblogs mention walking activities about historical buildings which leaders would plan walking route and introduce their history. Those activities also increase the volume of Weibo pictures about buildings. They post their experience and photos on social media to show their feelings. It's interesting to figure out that the greenery of BSV is nearly double than that of Weibo picture.

Table 2. Image recognition result of Baidu Street View and Weibo Pictures(%)

	Road	Sidewalk	Building	Wall	Fence	Pole	Vegetation
Weibo pictures	0.090	0.032	0.385	0.016	0.015	0.007	0.288
BSV	0.013	0.015	0.140	0.001	0.011	0.002	0.573
	Terrain	Sky	Person	Bicycle	Car	Truck	Motorcycle
Weibo pictures	0.011	0.049	0.038	0.003	0.016	0.023	0.002
BSV	0.010	0.215	0.004	0.001	0.007	0.006	0.001

By assigning the greenery value of each sampling point to the nearest street segment, the visible greenery of each street segment can be obtained by the average. The average visible greenery of all street is 58.23%, of which the visible greenery of style-protected roads is 63.39%, the visible greenery of other roads is 50.22%. Walking in the style-protected road can experience a richer street greenery and bring more happiness. Roads like Rd. Julu and Rd.Hengshan have higher visible greenery while some highways like Rd.Yanan have lower visible greenery. The urban street landscape includes the public space formed by the natural history and the walking trees in the space, under the guidance of the Protection Plan of Shanghai Historic District, the street space and the walking tree are used as the greening subject in the open space of the scenic area, and the "need to increase the scope of greening planting" in the non-greening land has a positive effect on the results of the current high visible greenery.

Comparing the results of Street View image recognition with the results of Weibo photo image recognition (Fig. 6), there are three kinds of cases that can be explored in greenery:

(1) The high rate of greenery in BSV and Weibo pictures, that is, the perceived record of street greening in urban space by users, such as Rd. Hengshan (Street View greening rate 51.92%, Weibo photo greening accounted for 37.4%), Rd. Julu Road (Street View greening rate of 72.4%, Weibo photo greening accounted for 35.91%)

(2) Greenery in BSV is high while in Weibo pictures is relatively low, that is, the greenery in urban space is not perceived by users, or other content attraction is higher. For example, the Weibo photos of Rd. Wanping and Rd. South Xiangyang focus more on small shops or building facades.

(3) Greenery in BSV is high while in Weibo pictures is relatively high, that is, the greenery in urban space is magnified and get more record. For example, Rd. Yongjia and Rd. Anfu maintain great greening landscape. Urban design increase the vertical greening, enhancing the crowd's perception of greening. It may be considered to increase vertical greening in subsequent street design if it’s appropriate. And it would increase the perception of greening among the population.

Figure.6. The comparison of greenery

The discussion about ‘Leave fallen leaves’

Since 2013, Shanghai has conducted the program ‘Leave fallen leaves’. It is expected that in mid-November, most of these landscape roads, which do not sweep the leaves, will enter the best viewing period, and the falling leaves will be woven into a variety of "carpets". So that the autumn in Shanghai is full of vitality and temperature. In 2018 there are 34 roads were chosen as Landscape Road, involving district Huangpu, Jinan, Xuhui and so on. The program started at 2018/11/15(Figure.7).

Figure.7. The timeline of ‘Leave fallen leaves’

Hengfu historical conservation area is in District Xuhui and some roads are chosen as Landscape Road. Last year officers invited some artists to create some art work which is about ‘Silk road’, an ancient commercial road connecting Eastern and Western. The exhibition stared in 2018/11/23 and contained 12 sets of art work which use leaves, branches, soil, stone and other elements. While one day later some complains about the exhibition appeared on social media because citizens thought those work is too surprising and strange. As seen in Figure.8, it could be track that on. Nov, 24 and 25 there was a peak to identify more than 20 users had posted program-related microblog. Some microblog directly expressed their opinions to organizer that those art works were not fit landscape. Some planners also share their opinion about artwork and how to better treat fallen leaves. On Nov,26 the organizer quickly changed the artwork and replied to people on social media.

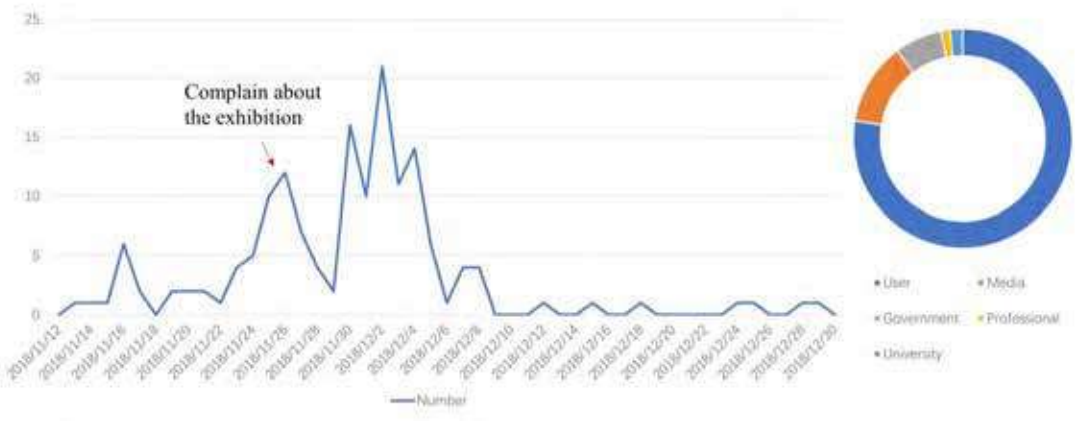

Figure.8. The number of Weibo post during the program

Since December 1, Shanghai has been in the most beautiful leaf season and there were 2nd peak of the discussion. Many people went to the landscape streets and post beautiful pictures on their social media with tag #Leave fallen leaves. With the track of tag, we collect text and conduct Semantic recognition to figure their attitude and emotion. As seen in Figure 9, the words in the top ten of the release volumes are ‘Fallen leaves’, ‘Leave’, ‘Shanghai’, ‘Landscape’, ‘Rd. Fuxing’, ‘Sidewalk’, ‘Citizens’, ‘Beautiful’, ‘Work of art’, ‘Question’. It shows people keep the program in close connection with city and even a specific road. Some microblog mention those art installation just copy an icon and carry a subject directly to Shanghai without creation, triggering more discussion. Although there were some complain before, we figured that ost people expressed a positive attitude about the program and share their thanks to the beauty of street.

Figure 9. The Semantic recognition result

Conclusion

This study attempted to map historical streets on social media with the help of new urban science. By the help of new technologies like Image recognition and new urban data, the visible and recorded street features could be measured. Building, greenery and sky were the focus of attention of the crowd. It's also helpful to organize walking activities to help people focus back to streets. Through the comparison of two kind of pictures, we find some streets have improved people's contact with greening through the design of vertical greening. The streets interacted with the online crowd with the help of social media. The case from 'Leave fallen leaves' show what's peoples' attitude about street landscape .Urban planners may use social media to get people's attitude and conduct public participate.

Despite the contribution of this study in mapping historical streets on social media, there is some limitations that require further research. For example, if the difficulty of collecting Weibo text and pictures by Python could be overcome, the quantity of objective would increase and present more objective state. Furthermore, the attraction of streets is also connected with the type of shop and activities hold by businessman, it would be better to join more social activities and expression on social media.

Contribution

Conceptualization, H.T. and W.W.; investigation, H.T.; data curation, H.T.; writing, H.T.; review and editing, W.W.

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