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Shujing Wang, Haibin Tang

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An extraction method of environmental behaviour characteristics in landscape design

Shujing Wang

School of Art and Design,
Jilin University of Architecture and Technology,
Changchun 130114, China
Email: 1045272382@qq.com

Haibin Tang*

Nissho Gakuen Chang Chun High School,
Changchun 130031, China
Email: haibin@mls.sinanet.com
*Corresponding author

Abstract: Aiming at the problems of low extraction accuracy and long extraction time in the traditional landscape environmental behaviour feature extraction method, this paper puts forward the environmental behaviour feature extraction method in landscape design. Firstly, the environmental behaviour factors are analysed according to the sense of comfort, security, communication, recognition and achievement, and the environmental behaviour data are obtained. Then, radiometric calibration, atmospheric correction, geometric correction and greyscale processing are carried out for the obtained behaviour data. Then, the scale difference is used to calculate the grey features and detail features of the preprocessed environmental behaviour image, and the grey features and detail features are weighted and fused to extract the environmental behaviour features of landscape architecture. Finally, the simulation results show that the accuracy of the proposed method for landscape environmental behaviour feature extraction is up to 100%, with high extraction accuracy and short extraction time.

Keywords: landscape architecture; landscape design; environmental behaviour; feature extraction; remote sensing image technology; greyscale processing.

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Biographical notes: Shujing Wang received her Master's degree in Design from Northeast Normal University in 2009. Currently, she is an Associate Professor at the School of Art and Design, Jilin University of Architecture and Technology. Her research interests include landscape architecture, indoor and outdoor design and animation design.

Haibin Tang received his Master's degree in Physical Education from Northeast Normal University in 2009. Currently, he works at Nissho Gakuen Changchun High School and is rated as the Backbone Teacher of Changchun City. His research interests include kinesiology, education, and psychology.

1 Introduction

Landscape architecture has become the most frequent place for tourists' outdoor leisure and entertainment. It is an important part of the park green space system (Zhang et al., 2019). However, there are still many problems in the existing landscape design, especially the contradiction between design and actual use (Tan et al., 2019). For a long time, most designers believe that the environment is the decisive factor of behaviour, and believe that users will consciously use the environment according to their design intention. Designers are more dedicated to fine combination structure, assumed function and aesthetic feeling of composition form, ignoring the fundamental needs of tourists for landscape environment and use function (Tang and Liang, 2020). Environmental behaviour refers to the activities that individuals exert direct and indirect influence on the environment. The characteristics of environmental behaviour are an important basis for landscape architecture design and are of positive significance to enhance the effectiveness and suitability of landscape architecture design. In order to design a better landscape architecture, it is necessary to extract the characteristics of environmental behaviour (Zou et al., 2021).

Chen et al. (2019) proposed a landscape environmental behaviour feature extraction method based on intelligent vision, used immune multi-agent method to perform immune multi-agent operation on landscape spatial images, analysed the impact of visitors' behaviour preference in landscape design, extracted environmental behaviour features and established feature extraction set according to the analysis results, Due to the noise in the data in the feature extraction set, it is necessary to carry out greyscale preprocessing. According to the preprocessing results, the video frame image array is established by using the video frame image array detection method, the greyscale pixel value is calculated, the optimal environmental behaviour features in the environmental behaviour feature set are obtained, and the environmental behaviour feature extraction of landscape architecture is realised. Huang et al. (2019) proposed a landscape environmental behaviour feature extraction method based on video data extraction, analysed the crowd behaviour through the monitoring video, collected the crowd behaviour data, constructed the landscape environmental behaviour feature extraction model according to the collection results, and extracted the crowd behaviour features in the landscape monitoring video. However, the extraction accuracy of landscape environmental behaviour features of the above two methods is low, resulting in poor extraction effect. Li et al. (2018) proposes a feature extraction method of landscape environmental behaviour based on segment key frames, collects landscape spatial environment design image frames in video stream, constructs video stream key frame model, takes image frames as input, inputs them into key frame model, obtains segment key frames, and identifies landscape environmental behaviour. According to the recognition results, The double stream convolution neural network is used to extract the environmental behaviour characteristics of landscape architecture. Bi (2019) proposed a method for extracting environmental behaviour features of landscape architecture based on regional feature fusion rules. The landscape spatial pattern image is obtained through remote sensing technology, and the remote sensing image is used as the data source. However, due to noise interference, the data source is decomposed by two-dimensional discrete wavelet analysis scale function to remove the noise in the data source, The wavelet variance method is used to recognise the scale of the remote sensing image of the spatial pattern distribution of landscape without

noise. According to the recognition results, the environmental behaviour characteristics of landscape are extracted under the regional feature fusion rules. However, the above two methods take a long time to extract the environmental behaviour characteristics of landscape architecture, resulting in low extraction efficiency.

In view of the problems existing in the above methods, this paper proposes an environmental behaviour feature extraction method in landscape architecture design, and verifies the reliability of this method through simulation experiments, which solves the problems existing in the traditional methods. The specific research route of this method is as follows:

1 Analyse environmental behaviour factors, including comfort, security, communication, recognition and achievement.

2 According to the environmental behaviour factors analysed in step 1, the landscape environmental behaviour evaluation system is constructed to obtain the environmental behaviour data.

3 Based on the behaviour data obtained in step 2, radiometric calibration, atmospheric correction, geometric correction and greying processing are carried out.

4 The grey value pyramid and detail pyramid are established, and the landscape environmental behaviour image preprocessed in step 3 is input into the grey value pyramid and detail pyramid. The grey feature and detail feature of the environmental behaviour image are obtained by using the inter scale difference, and the grey feature and detail feature are weighted fused to extract the environmental behaviour feature.

2 Extraction method of environmental behaviour characteristics in landscape design

2.1 Analysis of environmental behaviour factors

Landscape architecture design is a process of creating a beautiful natural environment by means of landscape art and engineering technology in a certain region, such as transforming terrain, planting plants, building buildings and arranging garden roads. In landscape architecture design, there will be a sense of comfort, security, communication, recognition and achievement. Environmental behaviour factors will be analysed to lay the foundation for subsequent environmental behaviour feature extraction (Yuan and Xue, 2018).

2.1.1 Comfort

Comfort refers to the visual feeling and experience provided by landscape architecture for tourists.

2.1.2 Sense of security

The sense of security of landscape architecture refers to the security of external environment and tourists' psychology. The safety of external environment refers to the safety of facilities in landscape architecture. The psychological safety of tourists refers to

the psychological impact of architectural facilities in landscape architecture on tourists (Liang and Li, 2018).

2.1.3 Sense of communication

In his hierarchy of needs theory, American Neo Confucianism and Maslow once mentioned that 'belonging and love' are people's basic psychological needs and the internal driving force of communication, which need to be realised through communication with other individuals or groups. The utilisation rate of landscape architecture has become the focus of its spatial design. Reasonable scale and comfortable facilities will promote people's communication, which is conducive to the formation of a sense of belonging (Zhang et al., 2018).

2.1.4 Sense of recognition

Usually, people's cognition of their living environment depends on relevant identification signs. For example, add personalised style design in the entrance hole and building exterior wall, so as to make it different from other landscape architecture, make tourists have a sense of recognition, and even make them feel superior and proud, which will have an impact on the identification and sense of belonging of landscape architecture. Including whether the inlet lifting has strong identification characteristics. Whether the indication signs are set reasonably; Whether the landscape style has regional or cultural characteristics; Whether architectural sketches have personality style and are easy to impress (Jiang et al., 2018).

2.1.4 Sense of achievement

At the same time of landscape architecture design, provide tourists with the opportunity to actively participate in the design and management of living environment according to their own wishes, and make tourists feel satisfied to realise their self-worth, that is, a sense of achievement. In the sense of achievement, the most important factor is participation, which can be specific to raising flowers and grass, holding exhibitions, etc.

2.2 Environmental behaviour data acquisition

Remote sensing image technology is a means of remote sensing aerial photography, which can accurately obtain aerial data. Therefore, according to the environmental behaviour factors analysed above, the landscape environmental behaviour evaluation system is constructed through remote sensing image technology, as shown in Table 1.

According to the landscape environmental behaviour evaluation system constructed above, the landscape environmental behaviour data is obtained, and the data length is 10 GB (Yang, 2021).

2.3 Data preprocessing

Because the landscape environmental behaviour data obtained by remote sensing image technology will produce image distortion and noise due to radiation, atmosphere and various reasons in the process of obtaining image data, preprocessing is carried out for

the obtained landscape environmental behaviour data to reduce the time consumed in the extraction of landscape environmental behaviour features (Tordoni et al., 2020).

Table 1 Evaluation system of landscape environmental behaviour

First level indicator	*Secondary indicators*	*Three-level indicators*
Comfortability	Noise	Noise interference of surrounding or internal environment of garden landscape
	Greening	Aesthetic effect and management maintenance of plant configuration in garden landscape
	Facility	Layout of recreational and sightseeing facilities and basic service facilities such as seats, garbage cans and public toilets
	Tidy	Hygienic status of the overall environment of garden landscape
Sense of security	Night lighting	Lamp setting and night lighting effect
	Road layout	Road tour route layout, road width, pavement design, etc
	Facility safety	Safety of rest, entertainment and other facilities
	Spatial distribution	The rationality of spatial scale and location, and the consideration of tourists' psychological safety
Sense of communication	Activity space	Layout of activity space and creation of space communication atmosphere
Sense of recognition	Entrance design	Is the design of the entrance space obvious and recognisable
	Mandatory sign	Design and distribution of signs such as signs
	Landscape style	Is the style of the overall landscape unified and distinct
Fulfilment	Planting flowers and plants	Participate in planting activities in the landscape

2.3.1 Radiometric calibration

Most directly acquired image pixel values are quantised dimensionless DN values. When extracting the environmental behaviour characteristics of landscape architecture, the radiance value and reflectivity value of the image shall be used:

$$L = Gain * DN + Bias \tag{1}$$

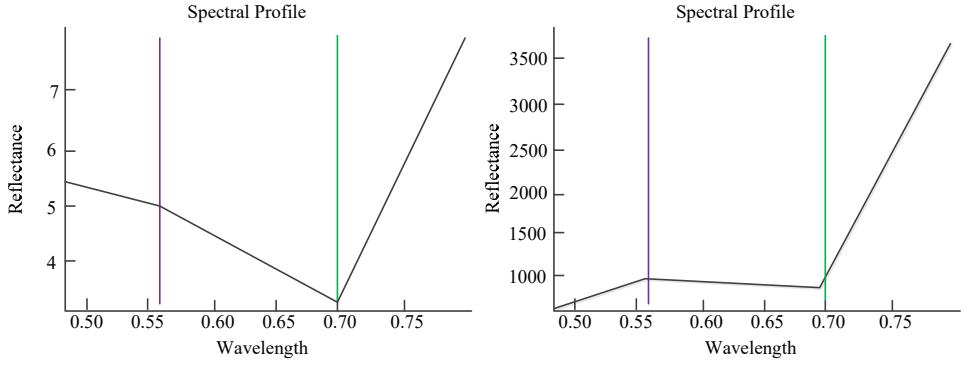
where L represents the radiance after conversion, DN represents the observed value of remote sensing load, $gain$ represents the gain of landscape environmental behaviour image, and $bias$ represents the offset of landscape environmental behaviour image (Hu and Liu, 2018).

2.3.2 Atmospheric correction

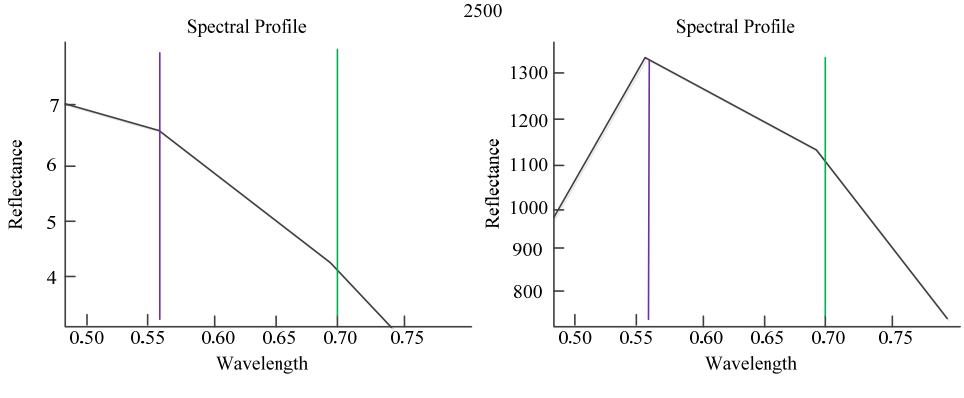
Accurate radiance value of environmental behaviour image is the premise of extracting environmental behaviour characteristics of landscape architecture. Therefore, MODTRAN4 radiation transfer model is adopted to correct the pixels of landscape

environmental behaviour image according to the geographic location, longitude and latitude and shooting time, and select the corresponding atmospheric mode. After correction, the atmospheric visibility is 40 km. Figure 1 shows the spectral curve of landscape environmental behaviour before and after atmospheric correction. It can be seen from the figure that the spectral curve is closer to the real reflection spectrum of environmental behaviour image (Zhang, 2020).

Figure 1 Spectral curve of environmental behaviour image before and after atmospheric correction, (a) spectral curve before (left) and after (right) atmospheric correction of environmental behaviour image (b) spectral curve before (left) and after (right) atmospheric correction of environmental behaviour image (see online version for colours)



(a)



(b)

2.3.3 Geometric correction

In the process of obtaining landscape environmental behaviour data through remote sensing image technology, distortion will occur for various reasons. Therefore, geometric registration is required to correct the landscape environmental behaviour image. The distortion correction model of landscape environmental behaviour image is constructed by polynomial method, and its expression is:

$$\begin{cases} x = a_0 + (a_1 X + a_2 Y) + (a_3 X^2 + a_4 XY + a_5 Y^2) + \ldots \\ y = b_0 + (b_1 X + b_2 Y) + (b_3 X^2 + b_4 XY + b_5 Y^2) + \ldots \end{cases} \tag{2}$$

where x, y represents the coordinates of GF-1/WFV control points, X, Y represents the coordinates of L and a8/OLI of pixels with the same name, and a, b represents polynomial coefficients.

2.3.4 Greyscale processing

The weighted average method is a better image greyscale processing method. Therefore, this paper uses the weighted average method to process the landscape environmental behaviour image, and the obtained greyscale image changes more obviously, which can not only improve the image definition, but also improve the effect of landscape environmental behaviour feature extraction (Wang and Qin, 2021). Set the R, G and B components of landscape environment behaviour image, give different values, and calculate the weight of R, G and B, whose expression is:

$$\mathrm{R} = \mathrm{G} = \mathrm{B} = \mathrm{OE} + \mathrm{PG} + \mathrm{QB} \tag{3}$$

where O, P, Q are the weights of each component. When O = 0.30, P = 0.59, Q = 0.11, calculate the grey value:

$$\mathrm{R} = \mathrm{G} = \mathrm{B} = 0.03\mathrm{R} + 0.59\mathrm{G} + 0.11\mathrm{B} \tag{4}$$

According to the above, obtain the greyscale processing results of landscape environmental behaviour image:

$$g(x, y) = \begin{cases} f(x, y) - f(x, y)^2 \\ f(x, y) + f(x, y)^2 \end{cases} \tag{5}$$

where $g(x, y)$ and $f(x, y)$ are the landscape environmental behaviour image and the original image after grey processing respectively (Li et al., 2021).

2.4 Extraction of environmental behaviour characteristics of landscape architecture

The characteristics of the preprocessed landscape environmental behaviour data are extracted. Firstly, the grey value pyramid and detail pyramid are established, the landscape environmental behaviour image is input into the grey value pyramid and detail pyramid, the scale difference is used to obtain the grey feature and detail feature of the environmental behaviour image, and the weighted fusion calculation is carried out to extract the environmental behaviour feature and obtain the landscape environmental behaviour feature value, Thus, the extraction accuracy of environmental behaviour features of landscape architecture is improved. The specific steps are as follows:

Set the processed landscape environment behaviour image as $g(x, y)$, use Mallat algorithm to wavelet decompose $g(x, y)$ and establish grey value pyramid. Based on the high-frequency component, establish detail pyramid according to the wavelet decomposed image. The size of grey value pyramid $L_k(s)$ and detail pyramid $O_k(s, d)$ is s and the direction is d, By establishing grey value pyramid and detail pyramid, the grey features and detail features of environmental behaviour image can be obtained (Baudouin et al., 2018).

Set the contrast measurement value as r and the characteristic area of landscape environmental behaviour as σ_c and σ_s, respectively. Use the inter scale difference to calculate the local contrast of landscape environmental behaviour images in a certain range and different locations, and its expression is as follows:

$$S = \frac{1}{2\pi\sigma_c^2}\exp\left(-\frac{r^2}{2\sigma_c^2}\right) - \frac{1}{2\pi\sigma_s^2}\exp\left(-\frac{r^2}{2\sigma_s^2}\right) \tag{6}$$

According to the local contrast obtained by the above formula, it can enhance the contrast effect of the image and further improve the accuracy of landscape environmental behaviour feature extraction (Lata et al., 2020).

Set the environmental behaviour images of coarse scale and fine scale as $F(c)$ and $F(s)$, respectively, and calculate the inter scale difference $F(c, s)$ between them:

$$F(c, s) = TF(c) * F(s)S$$

where T represents the inter scale difference coefficient. $F(s)$ adjusts the difference to the landscape environment behaviour image area with the same scale as $F(c)$, which is represented by $L_k(c)$ and $L_k(s)$, subtracts each point, and takes the corresponding absolute value $O_k(c, d)$ and $O_k(s, d)$, so as to obtain the grey feature $L_k(c, s)$ and detail feature $O_k(c, s, d)$ of the landscape environment behaviour image. The formula is as follows:

$$\begin{cases} L_k(c, s) = L_k(c) * L_k(s)F(c, s) \\ O_k(c, s, d) = O_k(c, d) * O_k(s, d)F(c, s) \end{cases} \tag{8}$$

Set $G_k(i, j)$ to represent the grey value of the $(i, j)^{\text{th}}$ pixel in the landscape environment behaviour image; $G_{k-m}()$ represents the translation estimator, which is used to calculate the landscape environmental behaviour characteristics display figure $M_k(i, j)$, and its expression is:

$$M_k(i, j) = G_k(i, j) - G_{k-m}(i - dy, j - dx) \tag{9}$$

where $G_{k-m}()$represents the difference of translation, dx and dy represent the estimator of environmental behaviour characteristics of landscape architecture

Design α, β, γ represent the weighting factor. According to the grey features and detail features of the landscape environmental behaviour image calculated above, the landscape environmental behaviour features are weighted and fused to extract the landscape environmental behaviour features. The expression is:

$$S_k = \frac{\alpha N(L_k) + \beta N(O_k) + \gamma NM(G_k)}{M_k(i, j)} \tag{10}$$

Among them, $N(L_k)$ represents grey, $N(O_k)$ represents details, $M(G_k)$ represents the normalisation function of landscape environmental behaviour image, and S_k represents the last extracted landscape environmental behaviour characteristic value.

To sum up, on the basis of radiometric calibration, atmospheric correction, geometric correction and greyscale processing of environmental behaviour data, this paper uses the inter scale difference to obtain the grey features and detail features of environmental behaviour image, and weights and fuses the grey features and detail features to extract the environmental behaviour features of landscape architecture, It not only improves the extraction accuracy of landscape environmental behaviour features, but also shortens the extraction time.

3 Simulation experiment analysis

3.1 Experimental scheme

In order to verify the effectiveness and reliability of the environmental behaviour feature extraction method in the practical application of landscape design proposed in this paper, taking the landscape design of a city as the research object, a simulation experiment analysis is carried out through the MATLAB simulation test tool. The landscape design of landscape architecture is shown in Figure 2.

Figure 2 Landscape design (see online version for colours)

Using the feature extraction method based on video data extraction proposed in Huang et al. (2019) and the feature extraction method based on segment key frame proposed in Li et al. (2018) as the comparison method, and taking the extraction accuracy and extraction time of landscape environmental behaviour features as the experimental indicators, the comparative experimental analysis is carried out.

3.2 Experimental environment

The main environment of the experiment and the selected tools are shown in Table 2.

Table 2 test environment settings

Name	*Parameter*
The server	Intel Xeon processor e5430 2.66 GHz, DDR3-1336 MHz, SSD 500 G
Client	Intel CPU 3.06 GHz, memory above 2 G, hard disk
Server operating system	Windows 2008 R2
Client operating system	Win 7
database	Oracle
database server	192.168.44.254
test tools	Mercury Loadrunner 6

3.3 Experimental data

Taking the landscape environmental behaviour data monitored by remote sensing as the image set and ten landscape environmental behaviour images belonging to the same target as a class, five landscape environmental behaviour images in the database are randomly selected as training video images for the first time, and the remaining five landscape environmental behaviour images are used as test video images, There are 200 images in the training image set and 200 images in the test image set, which is called 5train for short. For the second time, three landscape environmental behaviour images in the database are randomly selected as training images, and the remaining seven images are used as test landscape environmental behaviour images, so there are 120 images in the training image set and 280 images in the test image set, which is called 3train for short.

3.4 Performance index

3.4.1 Extraction accuracy

The extraction accuracy can verify the extraction effect of landscape environmental behaviour features. The higher the extraction accuracy, the better the extraction effect of landscape environmental behaviour features. The expression is:

$$Accuracy = \frac{R_z}{R_{all}} \tag{11}$$

where R_z represents the number of correctly extracted samples and R_{all} represents the total number of samples.

3.4.2 Extraction time

Extraction time is the index that can best verify the extraction efficiency of environmental behaviour characteristics of landscape architecture. The shorter the extraction time, the higher the extraction efficiency, and vice versa. Its expression is:

$$\min T = \frac{Q_{all}}{F} \tag{12}$$

where Q_{all} represents the total amount of samples extracted; F represents the sample extraction efficiency.

3.5 Test and analysis of performance index

The percentage of landscape environmental behaviour feature extraction of the environmental behaviour feature extraction method in landscape design proposed in this paper is obtained through experiments, as shown in Table 3.

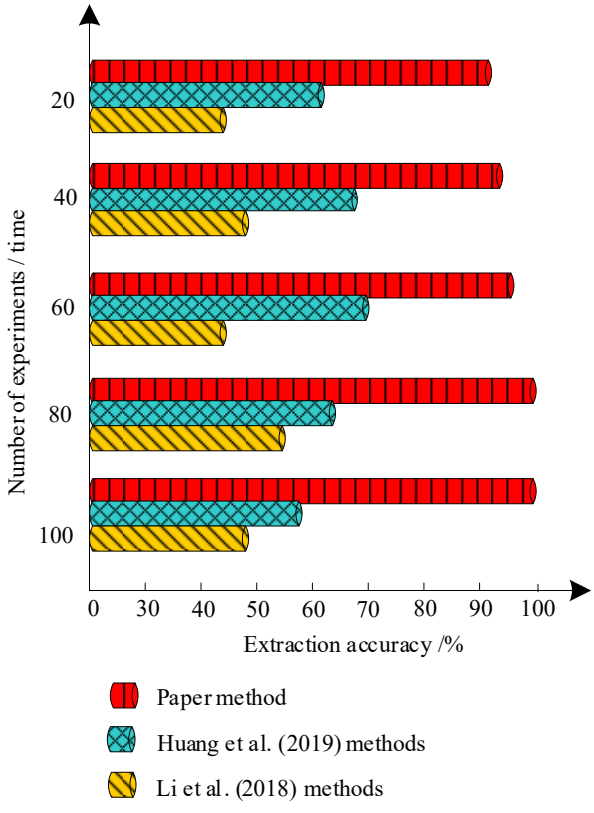
Table 3 percentage analysis of feature extraction

Target quantity	*5train*	*3train*
1	85.10%	85.46%
2	86.44%	80.12%
3	82.13%	82.25%
4	85.01%	80.00%
5	86.66%	79.45%
6	85.03%	78.11%
7	85.55%	76.23%
8	85.00%	75.00%
9	85.49%	75.00%
10	85.11%	74.22%
average value	78.08%	

As can be seen from Table 3, the landscape environmental behaviour feature extraction effect of the environmental behaviour feature extraction method in landscape design proposed in this paper is better at 5train, and the feature extraction percentage remains almost unchanged. However, at 3train, the landscape environmental behaviour feature extraction percentage decreases rapidly with the increase of the target number. The average percentage of feature extraction is 78.08%, which meets the requirements of landscape environmental behaviour feature extraction.

In order to further verify the extraction effect of this method, the environmental behaviour feature extraction method in landscape design proposed in this paper, the feature extraction method based on video data extraction proposed in Huang et al. (2019) and the feature extraction method based on fragment key frame proposed in Li et al. (2018) are used to compare and analyse the extraction accuracy of environmental behaviour features in landscape design, The comparison results are shown in Figure 3.

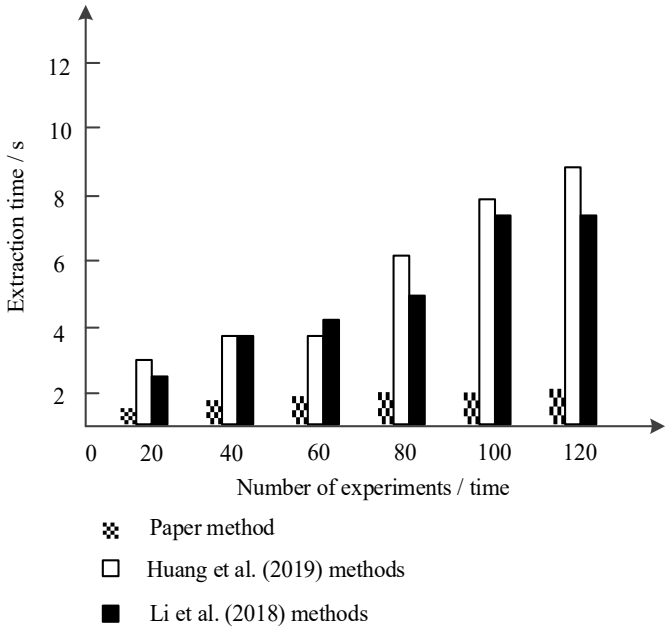
Figure 3 Comparison results of feature extraction accuracy of three methods (see online version for colours)



It can be seen from Figure 3 that the accuracy of landscape environmental behaviour feature extraction of the environmental behaviour feature extraction method in landscape design proposed in this paper can reach 100%, while the accuracy of landscape environmental behaviour feature extraction of the feature extraction method based on video data extraction proposed in Huang et al. (2019) is only 70%, and that of Li et al. (2018). The highest accuracy of landscape environmental behaviour feature extraction based on segment key frame feature extraction method is only 55%. The environmental behaviour feature extraction method in landscape design proposed in this paper has high accuracy and poor extraction effect.

In order to verify the effectiveness of this method, the environmental behaviour feature extraction method in landscape design proposed in this paper, the feature extraction method based on video data extraction proposed in Huang et al. (2019) and the feature extraction method based on fragment key frame proposed in Li et al. (2018) are used to compare and analyse the extraction time of environmental behaviour feature of landscape. The comparison results are shown in Figure 4.

Figure 4 Comparison results of feature extraction time of three methods



It can be seen from Figure 4 that the time for extracting the environmental behaviour characteristics of landscape architecture by using the environmental behaviour feature extraction method in landscape architecture design proposed in this paper is within 2 s, while the feature extraction method based on video data extraction proposed in Huang et al. (2019) and Li et al. (2018) are adopted The proposed feature extraction method based on fragment key frame takes 9 s and 8 s to extract the environmental behaviour features of landscape architecture. The environmental behaviour feature extraction method in landscape architecture design proposed in this paper takes less time and has higher extraction efficiency.

4 Conclusions

Due to the time-consuming and poor extraction effect of traditional methods for environmental behaviour feature extraction of landscape architecture, this paper proposes an environmental behaviour feature extraction method in landscape architecture design. Analyse the environmental behaviour factors, use remote sensing image technology to build the landscape environmental behaviour evaluation system and obtain the environmental behaviour data. However, the obtained environmental behaviour data will be distorted due to some external factors. Therefore, preprocess the landscape environmental behaviour data according to the processing results, Mallat algorithm is used to decompose the preprocessed data by wavelet to obtain the grey features and detail features of environmental behaviour image, and the grey features and detail features are weighted and fused to extract the environmental behaviour features of landscape architecture and obtain the characteristic values of environmental behaviour. The simulation results show that, compared with the traditional feature extraction methods,

the environmental behaviour feature extraction method in landscape design in this paper has better extraction effect and good application prospect, and can lay a foundation for landscape planning. It is hoped that this research can provide a certain value reference for relevant research. This method has the following advantages:

1 Using the environmental behaviour feature extraction method in landscape design, the accuracy of landscape environmental behaviour feature extraction can reach 100%. The landscape environmental behaviour feature extraction accuracy of this method is high and the extraction effect is good, because this paper uses the scale difference to obtain the grey features and detail features of environmental behaviour image, The weighted fusion calculation is carried out to extract the environmental behaviour characteristics, which improves the extraction accuracy of the environmental behaviour characteristics of landscape architecture.

2 Using the environmental behaviour feature extraction method in landscape design to extract the environmental behaviour feature of landscape architecture takes less than 2 s. The environmental behaviour feature extraction time of landscape architecture in this method is shorter and the extraction efficiency is higher because this paper preprocesses the obtained environmental behaviour data of landscape architecture, In order to reduce the time consumed in the extraction of environmental behaviour features of landscape architecture.

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