Urban Image Segmentation in Media Integration Era Based on Improved Sparse Matrix Generation of Digital Image Processing

Dan Zheng*, Yan Xie
School of Humanities and Communication, University of Sanya,
Sanya, Hainan 572000, China

***Abstract*—Media integration integrates the resources of various media platforms, including audience, technical and human resources. In the era of media integration, media in various channels, at different levels and in different fields provide various choices for image communication and brand building of cities. The technology of image processing by computer has gradually affected all aspects of people's life and work, bringing more and more convenience to people. In this paper, the application of digital image processing technology in city image communication in the age of media integration is studied. A new sparse matrix creation method is proposed, and the created sparse matrix is used as the similarity matrix to segment the spectral clustering image, so that the edge contour weakened in gradient calculation can be corrected and strengthened again. The research shows that the improved algorithm is superior to the traditional algorithm, and compared with the fuzzy entropy algorithm based on exhaustive search, the gray contrast between regions and Bezdek partition coefficient are improved by 9.301% and 4.127%. In terms of speed, the algorithm in this paper has absolute advantages, so our research is also affirmed, which fully shows that it should have high application value.**

Keywords*—Media integration; digital image processing; city image; image segmentation; improved sparse matrix generation

I. Introduction

Media combines the advantages of traditional media and new media, emphasizes the comprehensive application of text, pictures and image information, and increasingly highlights the value of images. By using computer technology, some textual descriptions are made into vivid images. Under the environment of media integration, the image of a city represents the characteristics of a city, and it is also the key factor that distinguishes it from other cities in the information explosion era. A good city image can not only show the achievements of urban construction, but also accelerate the process of urban development [1]. The technology of image processing by computer has gradually affected all aspects of people's life and work, bringing more and more convenience to people. In modern society, people's knowledge of unfamiliar cities is mainly obtained from the media, and the farther away the cognitive subject is from the city, the more people rely on the image spread by the media to get their knowledge, so the spread of city image cannot be separated from the media. On the platform of media, the new and old media penetrate, collide, advance and merge with each other, which constitute a prominent landscape of today's media ecology. Therefore, in the era of media integration, it is necessary to strengthen the extensive application of digital image technology, improve the production quality of publicity content, promote the steady improvement of information dissemination efficiency, and drive readers to form new information acquisition and reading habits.

For the analysis and research of city image, Mbaye and others think that the image and style of a city are the same. What the city style shows are a city's elegant demeanor, consciousness and landscape. It shows the cultural connotation and details of the city, the spiritual outlook of its citizens, and the development of its culture, economy, politics, science and technology [2]. M Ceren mainly divides the image of a city from two dimensions: subject and object. It is the main body of the city itself, that is, the overall style and features of the city, as well as its internal cultural connotation and quality, and the object is an abstract overall or intuitive evaluation of the city [3]. Kourtit et al. put forward the theory of urban image, first defined the concept of urban image, put forward five elements of urban image formation, and established a unique empirical research method of urban image [4]. Huijsmans et al., based on the theory of city image design and city management, discussed the potential and feasibility of city image visual management from the perspective of spiritual representation and management visualization [5]. Digital image processing technology mainly includes image processing, digital image coding, digital image inpainting, image segmentation and so on, which is widely used in different industries. In the field of media, digital image processing technology is mainly used in network transmission, advertising, film special effects production, post-processing and so on. According to recent published articles at home and abroad, the present situation and progress of digital image compression coding are carefully combed. Wang et al. summarized the basic theories and methods of digital image compression, and certified and studied several classical compression coding methods [6]. Da-Hai et al. adopted DCT (Discrete Cosine Transform), and its high bit rate (bit rate > 0.25 bit/pixel) can get a good compression ratio for continuous tone still gray or color images [7]. Ahmed et al. have made in-depth research on image segmentation methods based on graph theory, comprehensively utilizing various feature information, adopting various segmentation ideas and integrating various segmentation technologies, in order to reduce the computational complexity and improve the segmentation quality [8]. Wang et al. segmented the image by using the similarity of the internal feature information of the image area. However, the disadvantage of this method is that it is easy to generate false segmentation areas when segmenting complex and changeable natural images, thus resulting in over-segmentation [9]. Huang et al. proposed an image adaptive threshold selection algorithm based on wavelet analysis, which enables the feature points of image histogram to be expressed from coarse to fine by the feature points of wavelet transform, and enables the threshold to be adaptively selected [10]. Yan et al. proposed that the density and maximum distance product method should be used in the selection mechanism of the initial clustering center. User-interactive color migration is also proposed. This migration method selects sample blocks according to personal experience and objective basis, and specifies the corresponding relationship among the sample blocks, so as to realize color migration between images [11]. Oho et al. proposed an inpainting algorithm based on the interpolation of image gray level and gradient direction, which can simultaneously inpaint the topological structure and texture information in the image [12].

In the field of urban image segmentation, many researchers have proposed various methods based on sparse representation. However, these methods still suffer from high computational complexity and insufficient generalization ability when processing large-scale urban images. In addition, these methods often overlook features such as texture, color, and shape in urban images, resulting in poor segmentation performance. Therefore, it is necessary to improve the existing sparse representation methods to enhance the accuracy and efficiency of urban image segmentation.

In order to address the limitations and challenges of existing methods, this paper proposes a city image segmentation method in the media fusion era based on improved sparse matrix generation digital image processing. The main motivation of this method is to improve the accuracy and efficiency of urban image segmentation, while reducing computational complexity and data volume.

II. RESEARCH METHOD

A. Media Communication of City Image under the Environment of Media Integration

The public's cognition of the formation of a city is mainly carried out through traveling, listening to other people's stories, media reports, etc., and the public can't personally perceive all aspects of the city because of objective factors such as distance. Therefore, the public will choose the mass media to understand the image of a city, and after constant publicity, they will have an overall impression of a city. A good city media image is conducive to shaping the city image and attracting more audiences, while a good city media image is conducive to shaping the city image. A good city image can only be shaped by media reports and dissemination, so it is of great significance to study the city media image to recognize the city image.

City image communication power is the ability to realize the effective communication of city image, which directly determines the audience's awareness of city image. The knowledge about the city's citizens' contact with the outside public mainly depends on the mass media, but for the outside people in the city, such as tourists and migrant workers, they will not only get the city information through the mass media, but also supplement their cognition of the city image through the behavior identity of the city image. Through the planning of the city image communication power, the city image communication power can be brought into full play, thus enhancing the public's awareness of the city image. In the process of city image communication, the choice of city image positioning is to select the image information that can occupy a certain position in the public's mind and refine it from the public's preference. With the public as the center, the image of the city can be more easily accepted by the public, thus gaining the public's trust and goodwill. It provides information, channels and strategies for city image communication. At the same time, it deals with the feedback from the audience in a timely manner, and revises the communication strategies so as to better build the communication power of city image and establish a good city image service.

In the age of media integration, the media of various channels, different levels and different fields provide various choices for the image communication and brand building of the city. This kind of mass media's inherent focusing and spreading effect, as well as its functions of contacting the society, monitoring the environment, inheriting civilization, entertaining the public and mobilizing the society, make the mass media strategy enlarged into the exclusive strategy of city image communication in many researches and practices. However, it is undeniable that traditional media still plays an important role today. Traditional media still has its unique advantages in spreading city image, such as strong human and material resources, long-term accumulated rich experience, and lack of rigor, profundity and sense of authority of network media. Unlimited diversification of information channels is the biggest law of communication in the age of media integration. Traditional media can't monopolize the release of information. Self-media, represented by Weibo, has more and more right to speak, and has become an unquestionable and important part of information release channels.

In the era of media integration, the power of individuals and non-governmental organizations composed of individuals in the main body of city image communication cannot be ignored. The development and maturity of new media technology provide audiences with more platforms to spread information and express their personal views. In this highly open discourse space, ordinary citizens' awareness of spreading the city image is rapidly awakened, and they gradually change from passive to active in spreading the city image. They begin to use various media to express the city image in their hearts. Citizens in the city register their Weibo accounts and share their life in Weibo. Perhaps it's a city landscape, a city food, a feeling in city life, or a city building, all of which spread the image of the city in tangible and intangible ways. Because most people in the circle of friends are acquaintances, people will be more willing to share information about urban life on WeChat. The bits and pieces of urban life that people share on WeChat can be quickly seen by people in the circle of friends, which will lead to secondary transmission. Let the receiver of information interpret the image of the city, such as the urban buildings and customs contained in the published information. This kind of unconscious communication can sometimes bring unexpected communication effects.

At the same time, we should not only make use of emerging media to pay close attention to positive publicity, but also deal with negative information. The integrated media communication of city image must follow the communication law of multi-media era, comprehensively utilize all kinds of media, meet the information needs of different types of audiences, and carry out three-dimensional communication. In the way, we should not only keep the traditional advantages, but also be good at using new media. In terms of timing, we should not only have ideas and means in normal situations, but also take measures to deal with thinking and image restoration in critical times. City image communication has a distinct stage, changing with the times and its own development; from the microscopic point of view, any specific communication work is a certain stage in the process of city image communication. Compared with the other two forms of city image communication, interpersonal communication, memory communication and experience communication, the participation of the media will systematically and continuously spread the city image through news reports, which will have an impact on the audience's cognition and understanding of the city image in a long period.

B. Analysis of the Application of Digital Image Processing Technology in City Image Communication

With the advent of the age of media integration, images, as the visual basis for people to perceive the world, are an important means for people to obtain, express and transmit information. Computer technology is used to compress and encode images to complete digital image processing, and to transform low-quality images into high-quality images.

At present, the development of streaming media communication technology is relatively mature, and digital image processing technology is needed for image transmission. Digital image processing technology is widely used in streaming media, including high-speed color TV signal and high-compression image transmission. From the previous role of picture ornament and decoration to the application of digital image processing technology, more pictures with strong sense of scene, intuitive image and important subject matter are used, so that digital images can play a leading role in news reports.

1) Digital image compression technology: With the continuous development of multimedia technology and Internet technology, how to effectively organize, store, transmit and restore image data and explore more effective and higher compression ratio image coding technology has become one of the key tasks in information processing technology. the research and application of image compression coding is one of the most active fields in information technology at present. Image coding is to use different expression methods to reduce the amount of data needed to represent the image. the theoretical basis of compression is information theory. Without the rapid development of image compression technology, it will be difficult to realize the storage and transmission of large amount of information, and it will be difficult to play a role in multimedia and other application technologies. Therefore, data compression is very important for multimedia information such as images.

In order to express image data, some symbols need to be used, and image coding needs to use these symbols to express images according to certain rules [13-14]. Here, the symbol sequence assigned to each information or event is called the code word, and the number of symbols in each code word is called the length of the code word. Generally, the encoder includes three independent operations in sequence, while the corresponding decoder includes two independent operations in reverse order, as shown in Fig. 1:

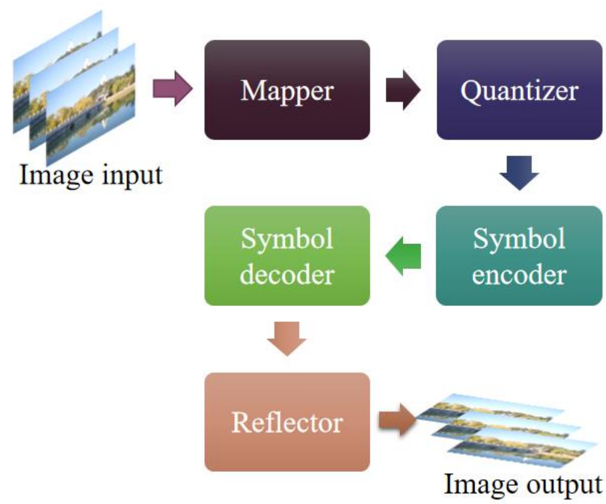

Fig. 1. Block diagram of image coding and decoding system.

In the encoder, the mapper reduces the pixel redundancy by transforming the input data; Quantizer reduces psychovisual redundancy by reducing the accuracy of mapper output; the encoder reduces coding redundancy by assigning the shortest code to the most frequent quantizer output value. Because the quantization operation is irreversible, there is no inverse operation module for quantization in the decoder [15].

For a random event E, if its occurrence probability is $P(E)$, then the information it contains is:

$$I(E)=\frac{1}{\log P(E)}=-\log P(E) \tag{1}$$

The source symbol set B is defined as the set (b_i) of all possible symbols, where each element b_i is called the source symbol, and the probability of the source generating the symbol (b_i) is $P(b_i)$.

For the effectiveness of image information transmission with large amount of data under the condition of high compression, the image to be compressed is preprocessed before it is compressed and coded to reduce the amount of information transmitted, and the decomposed wavelet coefficients can be appropriately changed, so that the compressed reconstructed image has better compression effect and subjective quality [16-17].

The "pure" anisotropic diffusion equation is adopted for the high frequency subband $HL_j, LH_j, HH_j \left(j = 1, \ldots, d \right)$. Carry out wavelet transform on the original image to obtain a wavelet image;

$$\left\{ u_{k,j} \middle| k = LL, LH, HL, HH; j = 1, \ldots, d \right\} \tag{2}$$

Initialization threshold T_0 (threshold to be used for the first scan):

$$T_0 = 2^{\left\lfloor \log_2 Max\left\{ \left| c_{i,j} \right| \right\} \right\rfloor} \tag{3}$$

Among them, $\left\{ c_{i,j} \right\}$ is the transform coefficient of L-level embedded zerotree wavelet transform, $\left| c_{i,j} \right|$ is the absolute value of $c_{i,j}$, and the relationship between the threshold of each scan and the threshold of its previous scan is: the current threshold is half of the previous threshold [18].

The sensitivity of human eyes to the change of gray scale is related to the background, and it changes with the change of average gray scale, that is, the resolution (vision) of human eyes to the details of the scene is related to the relative contrast C_r of the scene. The formula is as follows:

$$C_r = \left[\frac{B_1 - B}{B} \right] \tag{4}$$

where: B_1 is the brightness of the object; B is the background brightness; When C_r becomes small, vision decreases.

If a convolutional code with a code rate of R and a memory depth of M is used to send a message containing K information bits, the effective code rate is:

$$R_{eff} = \frac{K}{R^{-1}K + R^{-1}M} = \frac{RK}{K + M} = \frac{R}{\frac{M+1}{K}} \tag{5}$$

Therefore, convolutional codes are most effective at $K + M$, that is, the length of the information sequence to be sent is much longer than the storage length of the register.

2) Image segmentation technology: Image segmentation is an important image technology, which not only gets extensive attention and research, but also gets a lot of applications in practice. Image processing emphasizes the transformation between images to improve the visual effect of images. Image analysis is mainly to monitor and measure the objects of interest in the image, so as to obtain their objective information and establish a description of the image. They generally correspond to specific areas with unique properties in the image. In order to identify and analyze the targets, they need to be separated and extracted, and on this basis, it is possible to further utilize the targets. Image segmentation has been widely used in practice, such as industrial automation, online product inspection, production process control, document image processing, remote sensing and biomedical image analysis, security monitoring, military, sports, agricultural engineering and so on.

Segmentation is an important step in image analysis, image understanding and video coding, and it is also a basic technology in computer vision. This is because image segmentation, object separation, feature extraction and parameter measurement transform the original image into a more abstract and compact form, which makes it possible for higher-level analysis and understanding [19].

In this paper, the lost image information is analyzed, and a new sparse matrix creation method is proposed, and the created sparse matrix is used as similarity matrix for spectral clustering image segmentation. Gaussian function is used to calculate the similarity between pixels in an image.

$$w_{ij} = e^{\frac{-\left\| F(i) - F(j) \right\|_2^2}{\sigma_I}} * e^{\frac{-\left\| X(i) - X(j) \right\|_2^2}{\sigma_X}} \tag{6}$$

where: $F\left(\cdot\right)$ represents the gray value, and $X\left(\cdot\right)$ represents the coordinates. σ_X, σ_I represents the scale parameters of coordinate distance and gray difference, respectively.

At any point in a complex image, the human eye can only recognize dozens of gray levels, but it can recognize thousands of different colors. Therefore, in many cases, only using gray level information can't extract a satisfactory target from the image. Color image segmentation can be regarded as the application of gray image segmentation technology in various color spaces.

Consider a two-dimensional gray (gradient) image I. The domain of I is $D_l \subset Z^2$, I takes discrete gray value $\left[0, N\right]$, which is regarded as the height of the corresponding pixel, and N is a positive integer:

$$I \begin{cases} D_l \subset Z^2 \to \left\{ 0, 1, \ldots, N \right\} \\ p \middle| \to I\left(p\right) \end{cases} \tag{7}$$

A path p of length l between points p, q in the image I is an $\left(l+1\right)$ group composed of points $\left(p_0, \ldots, p_{l-1}, p_l\right)$, with $p_0 = p, p_l = q$ and $\forall_i \left[1, l\right], \left(p_{i-1}, p_i\right) \in G$.

In order to make the edge detected by edge detection operator affect the result of region segmentation, these edges should be mapped to the position of "dam" in gradient image.

Based on this, this paper puts forward a gradient "peak enhancement" method, which can correct and strengthen the weakened edge contour in gradient calculation. Based on the above analysis, the basic flow of this segmentation scheme is shown in Fig. 2.

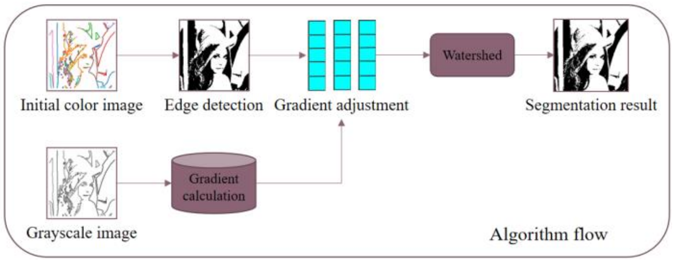

Fig. 2. Algorithm flow chart.

T is a threshold, and its value is related to the degree of noise pollution. It limits the range that the depth of point (x,y) is considered to be very close to the depth of its neighboring points. Only when the depth value of point (x,y) and its neighboring points are less than the threshold value, it is considered that point (x,y) is very close to the depth value of its neighboring points.

$$T^2 = \frac{1}{8}\sum_{i=0}^{7}\left(\delta_i(x,y) - f(x,y)\right)^2 \tag{8}$$

In order to make the color change independent of the change of light intensity in color image segmentation, an effective method is to uniformly obtain the change of intensity in spectral distribution. So a standardized color space is obtained, and its form is as follows:

$$r = \frac{R}{R+G+B} \tag{9}$$

$$g = \frac{G}{R+G+B} \tag{10}$$

$$b = \frac{B}{R+G+B} \tag{11}$$

Because of $r+g+b=1$, when two components are given, the third component is also determined. Usually, we only use two of the three components.

3) Image restoration technology: Image inpainting technology is a morbid problem. It is only a reasonable assumption based on mathematical principles, and it is analyzed from the perspective of computer vision and information theory. By comparing the rationality of various assumptions, the problem of image inpainting is finally solved. That is, the damaged area is artificially determined according to the color information and structural features in the image, and different colors are calibrated to distinguish the known area from the area to be repaired; Compared with the traditional manual method, today's image inpainting technology has developed by leaps and bounds in both efficiency and natural integrity. However, there are still a lot of problems in the field of image inpainting that need to be improved and solved urgently. As an important subject in image engineering, the field of image inpainting is attracting more and more researchers to join in.

Digital image inpainting technology is based on the problem that local information is missing in the process of digital image processing and compression in the past, and the object to be repaired is specially repaired. In particular, the restoration of cultural relics mainly involves manual restoration of cultural relics, which requires employees to have extremely high professional skills, patience and care, resulting in the inability of mass production of cultural relics restoration. However, the field of cultural relics restoration is very wide, and it is far from meeting the actual needs of cultural relics restoration only by manual restoration. For the possible negative effects of cultural relics restoration, digital image restoration technology can also provide certain anti-infection ability, avoid the serious impact of cultural relics restoration and improve the comprehensive utilization value of cultural relics [20]. Using the technical principles of statistics and other disciplines, the prediction model of cultural relics is constructed, and the existing image data is used to estimate the incomplete image area, so as to achieve the virtual restoration of cultural relics, which can shorten the original time-consuming work cycle of cultural relics restoration, and avoid the mistakes of manual restoration, resulting in more serious secondary damage to cultural relics. Reinforcement learning can be used for image segmentation tasks, learning how to classify images at the pixel level through interaction with the environment. The intelligent agent selects actions based on current observations and adjusts strategies based on feedback from the environment to optimize segmentation results. Reinforcement learning can be applied to target tracking tasks, where agents learn how to accurately track the position of target objects in consecutive frames. By defining appropriate reward functions, agents can learn to effectively track targets in complex scenarios. The combination of deep learning and object detection technology can achieve end-to-end object detection with higher accuracy and robustness. It trains neural networks to simultaneously predict the position and category of targets. For example, super-resolution reconstruction, style transfer, and image restoration. GAN consists of a generator and a discriminator, which generate new images similar to real images through adversarial training [21-23].

When studying image inpainting, the degradation model of the image can be expressed by the following formula:

$$u^0\big|_{\Omega\backslash D} = \left[k*u+n\right]\big|_{\Omega\backslash D} \tag{12}$$

Ω represents the target image; D represents the region to be repaired of the image; $\Omega\backslash D$ means the existing information in the image; u^0 is the available image part on $\Omega\backslash D$; u the target image to be restored; k represents its degradation function, n is the noise term, and "$*$" here represents convolution.

Generally, the energy form E for establishing its data model is defined by the minimum mean square error, and the formula is as follows:

$$E\left[u^0 | u\right] = \frac{\lambda}{2} \int_{\Omega \backslash D} \left(k * u - u^0\right)^2 dx \tag{13}$$

When partial differential equation theory is used for image inpainting, the D of the defect is unknown, so compared with other image processing projects, the prior model of the image is very important for the inpainting project.

Knowing the length, width and height of the cuboid can realize the complete reconstruction of the cuboid. The method proposed in this paper is to manually obtain the minimum number of image points, obtain their corresponding three-dimensional coordinates through camera calibration, and then calculate the length, width and height of the cuboid, thus realizing the complete reconstruction of the cuboid. The perspective projection of cuboid is shown in Fig. 3.

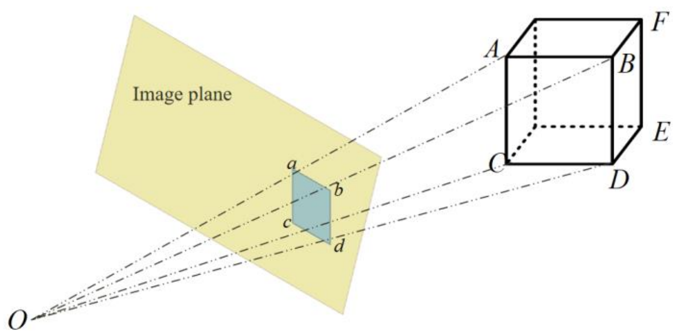

Fig. 3. Perspective projection of cuboid.

In the figure, O is the optical center of the camera, $ABCD$ is one surface of a cuboid, and its corresponding projection surface on the imaged image is $abcd$. Determine the depth value of one of the points in the camera coordinate system, calculate the three-dimensional coordinates of the manually obtained points according to the internal and external parameters calibrated by the camera, and then calculate the length, width and height of the cuboid according to its geometric properties.

The projection of the reverse $\vec{d}$ of any point x in the image is a ray determined by that point and the camera center. In the camera coordinate system, the ray direction $\vec{d}$ is:

$$\vec{d} = K^{-1} x \tag{14}$$

Therefore, A, B, C, D is on ray $\overrightarrow{Oa}, \overrightarrow{Ob}, \overrightarrow{Oc}, \overrightarrow{Od}$.

In an image, the damaged area (the area to be repaired) is usually irregular, so it is difficult to determine the geometric center of the area. In this paper, the concept of gravity center in physics is introduced by using the characteristic that the position of gravity center is only related to the image shape.

Assuming that Ω represents the damaged area, the coordinates of its center of gravity O can be calculated by the following formula:

$$\bar{x} = \frac{\sum\sum_{[x,y]\subset\Omega} \|x\|}{S} \tag{15}$$

$$\bar{y} = \frac{\sum\sum_{[x,y]\subset\Omega} \|y\|}{S} \tag{16}$$

where, S represents the area of the region Ω to be repaired (the sum of all pixels to be repaired).

III. Analysis and Discussion of Results

In the basic fractal algorithm, the quality of reconstructed image, coding time and compression ratio depend on many factors, such as the size of R block, D block, the step length of generating D block pool, whether to adopt basic transformation, brightness adjustment factor and the quantization bit number of brightness offset, etc. the program is written in C++, the coordinates of D block are stored in 16bit, and the serial number of basic transformation is stored in 3 bits. The R block size is 4×4 and the D block size is 8×8(B=4), and eight basic transformations are adopted.

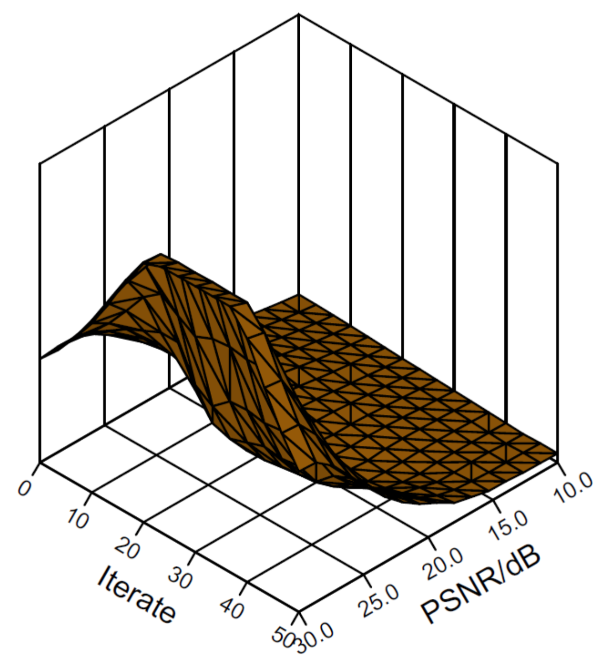

Fig. 4. The decoding convergence of lena image.

Analyze the decoding convergence of Lena image when the initial image is all black (see Fig. 4). It can be seen that the decoded image sequence of 10 times overlapping has basically converged. The difference between the decoded picture of the 10th overlapping and the PSNR (Peak Signal to Noise Ratio) after decoding is less than 0.051dB. Within the error range of 0.051dB, the decoded image of the 10th overlapping reaches the convergent image of the decoded image sequence.

Lena standard grayscale test chart with 516× 516, 8-bit quantization is used (see Table I and Fig. 5).

TABLE.I FRACTAL CODING

T	PSNR (dB)	Compression ratio	Coding time (s)
2	28.2349	5.8949	3.3796
6	26.1433	6.6526	2.8584
14	24.5524	12.3785	2.839

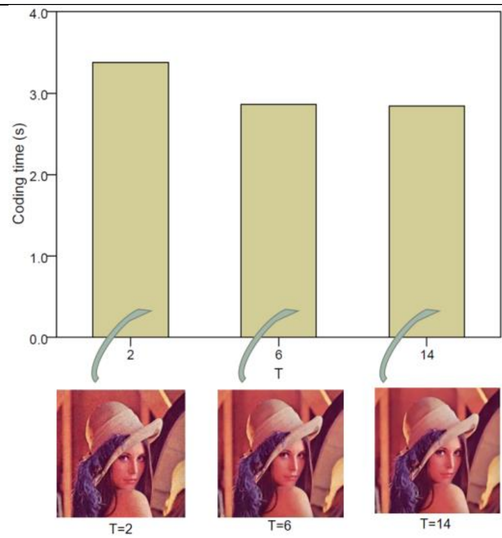

Fig. 5. Fractal time histogram.

The image reconstruction of neighborhood search fractal block coding is basically the same as that of global search fractal block coding, except that neighborhood search fractal block coding only iterates repeatedly in the neighborhood when reconstructing the image. This method limits the search process of the matching block to the four neighborhoods of the range block, which ensures the SNR and greatly reduces the coding time. However, with the increase of threshold, there is block effect in the decoded image, which is a shortcoming that this algorithm needs to overcome.

Influence of backtracking length on performance of convolutional codes. The length of backtracking not only determines the accuracy of Viterbi decoding, but also affects the decoding delay, and the error performance will also change accordingly. The feedback depth is 10, 15, 26 and 31 respectively. The simulation results are shown in Fig. 6.

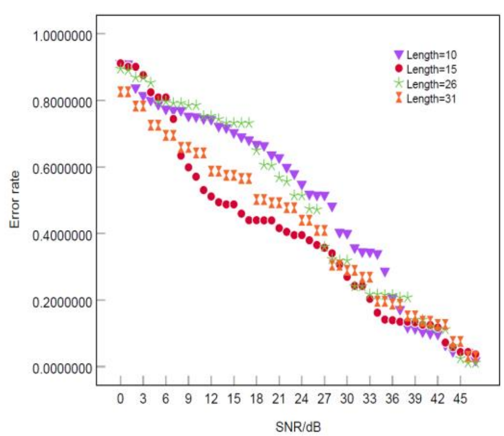

Fig. 6. Influence of different backtracking lengths on the performance of convolutional codes.

When the SNR (Signal to Noise Ratio) gradually increases, the bit error rate of the system gradually decreases with the increase of the backtracking length, but when the backtracking length increases to 5N, the bit error rate does not change much, and the (2, 1, 6) convolutional code here basically tends to be stable when the backtracking length reaches about 31. Therefore, when selecting the backtracking length, it is usually 5N.

Table II and Fig. 7 show the time taken by the fuzzy entropy algorithm based on exhaustive search and the algorithm in this paper to binarize sample images, where the unit of time is seconds.

The experimental results obtained by using the algorithm in this paper are basically the same as those obtained by fuzzy theory processing developed in the field of segmentation in recent years. However, the chart shows that the algorithm in this paper has absolute advantages in speed, so our research is also affirmed, which fully shows that it should have high application value.

To verify the effectiveness of the proposed algorithm, two quality indexes, i. e. gray contrast between regions and Bezdek partition coefficient, are selected to quantitatively analyze and compare the three algorithms involved. In general, the greater the gray contrast between regions, the better the image segmentation quality.

TABLE.II COMPARISON OF TIME

Image sequence number	Fuzzy entropy	Our
1	176.4963	0.6217
2	76.4064	1.1349
3	75.695	0.1376
4	185.0856	0.3185
5	183.5306	0.9046
6	229.1597	0.9303
7	91.1172	0.9817
8	193.1467	0.3634
9	202.0152	0.4158
10	172.9026	0.5851
11	205.0024	1.0143
12	55.7282	1.0713
13	159.9875	0.4138
14	174.3161	1.0269
15	64.1679	0.971
16	105.5269	0.2388
17	85.0808	1.0401
18	70.3764	0.0164
19	143.932	0.6305
20	196.2099	0.5157

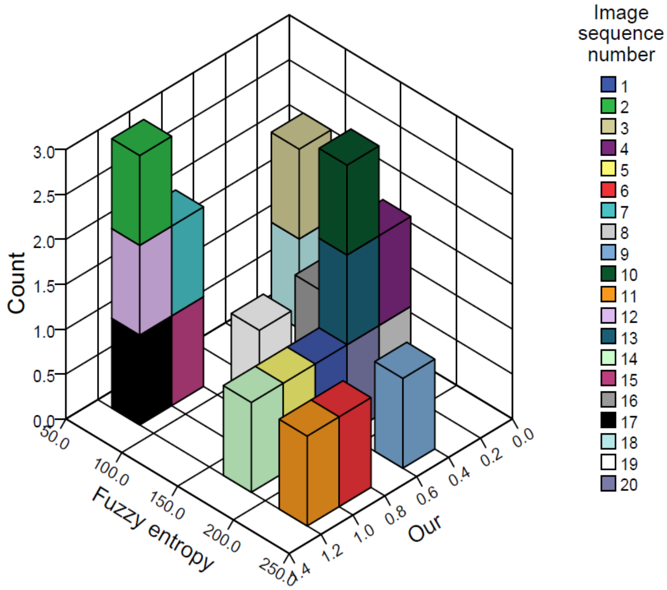

Fig. 7. Algorithm time comparison chart.

If there are multiple areas in a picture, calculate the contrast between two adjacent areas and then sum and compare. The larger the Bezdek partition coefficient is, the greater the membership of pixels within a class is, and the smaller the membership of pixels between classes is, and the better the segmentation effect is. The experimental results are shown in Table III and Table IV, Fig. 8 and Fig. 9.

TABLE.III COMPARISON OF GRAY CONTRAST BETWEEN REGIONS

Image sequence number	Fuzzy entropy	Peak detection	Our
1	0.1725	0.1974	0.4955
2	0.1973	0.2026	0.4995
3	0.2063	0.2082	0.5029
4	0.2117	0.2395	0.53
5	0.2362	0.2577	0.5546
6	0.2507	0.2675	0.5554
7	0.2527	0.2821	0.5599
8	0.2672	0.2875	0.6057
9	0.3004	0.3153	0.6216
10	0.303	0.3321	0.6252
11	0.3313	0.3391	0.6429
12	0.3357	0.3479	0.6494
13	0.3358	0.3483	0.6544
14	0.3595	0.3577	0.6575
15	0.3666	0.3666	0.7828
16	0.3989	0.375	0.7864
17	0.4099	0.4208	0.7965
18	0.4297	0.4475	0.8678
19	0.466	0.4687	0.8799
20	0.4743	0.4968	0.8824

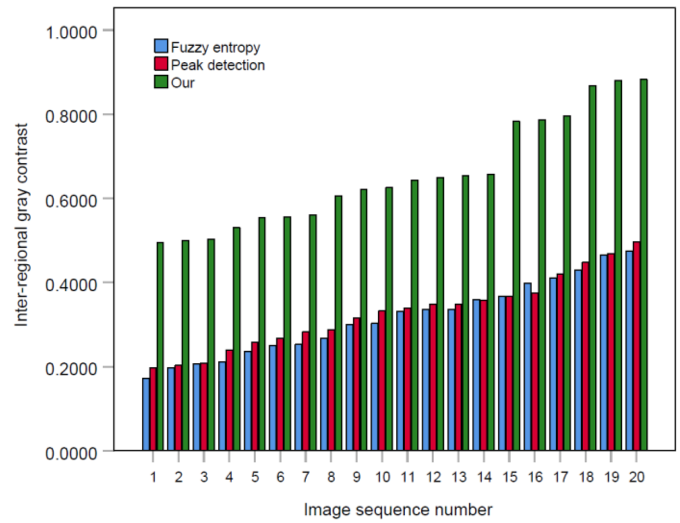

Fig. 8. Comparison chart of gray contrast between regions.

TABLE.IV COMPARISON OF BEZDEK PARTITION COEFFICIENTS

Image sequence number	Fuzzy entropy	Peak detection	Our
1	0.8723	0.8344	0.9953
2	0.8575	0.8332	0.9794
3	0.852	0.827	0.974
4	0.85	0.823	0.9732
5	0.8438	0.8185	0.9599
6	0.8417	0.8123	0.9586
7	0.8416	0.8048	0.9557
8	0.8376	0.7924	0.952
9	0.8282	0.789	0.9394
10	0.8158	0.7869	0.9348
11	0.8157	0.7853	0.9345
12	0.8143	0.7734	0.9306
13	0.8134	0.7616	0.9238
14	0.8089	0.7548	0.9176
15	0.8033	0.7499	0.9122
16	0.8021	0.7259	0.9059
17	0.7911	0.7256	0.8953
18	0.7907	0.689	0.8851
19	0.7768	0.6832	0.88
20	0.7606	0.6703	0.862

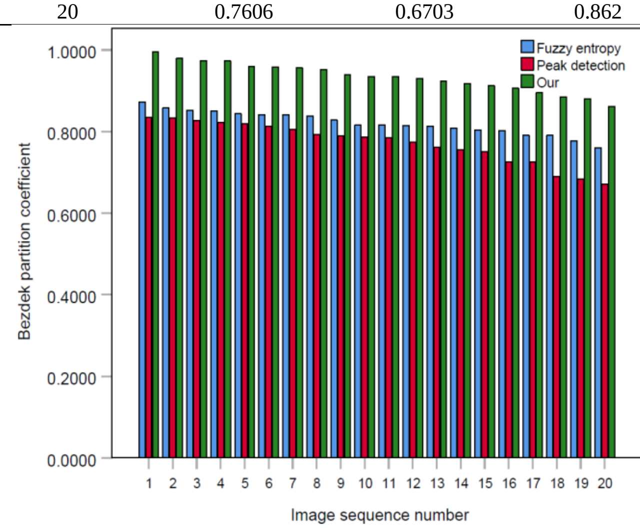

Fig. 9. Comparison chart of Bezdek partition coefficient.

In this paper, the original image is pre-segmented by using the established graph model. The initial clustering center of the algorithm is obtained by hierarchical clustering of the obtained similarity matrix. It can be seen from the two quality indexes of inter-regional gray contrast and Bezdek partition coefficient involved in the above chart that the improved algorithm in this paper is superior to the traditional algorithm. Compared with the fuzzy entropy algorithm based on exhaustive search, the inter-regional gray contrast and Bezdek partition coefficient are improved by 9.301% and 4.127%.

The urban image segmentation method based on improved sparse matrix generation for digital image processing in the era of media fusion has broad application prospects in the real world. For example, in urban planning and construction, this method can help urban managers better understand and analyze urban spatial layout and landscape characteristics, providing more accurate data support for urban planning decisions. At the same time, this method can also be applied to urban image dissemination strategies, by using precise image segmentation techniques to highlight the characteristics and highlights of the city, and improve its visibility and reputation.

In addition, the urban image segmentation method in the media fusion era based on improved sparse matrix generation digital image processing can also be applied in fields such as tourism, transportation, and environmental monitoring. For example, in the field of tourism, this method can help tourists better understand the characteristics and landscape layout of tourist attractions, and improve the quality of tourism experience; In the field of transportation, this method can help traffic management departments better understand road conditions and traffic flow, providing more accurate data support for traffic planning and governance; In the field of environmental monitoring, this method can help environmental protection departments better understand the situation of environmental pollution and ecological change trends, and provide more accurate data support for environmental protection decision-making.

IV. Conclusion

City image communication power is the ability to realize the effective communication of city image, which directly determines the audience’s awareness of city image. On the platform of media, the new and old media penetrate, collide, advance and merge with each other, which constitute a prominent landscape of today’s media ecology. Through the planning of the city image communication power, the city image communication power can be brought into full play, thus enhancing the public’s awareness of the city image. In this paper, the application of digital image processing technology in city image communication in the age of media integration is studied. A new sparse matrix creation method is proposed, and the created sparse matrix is used as similarity matrix to segment spectral clustering images. Gaussian function is used to calculate the similarity between pixels in an image. the research shows that the improved algorithm is superior to the traditional algorithm, and compared with the fuzzy entropy algorithm based on exhaustive search, the gray contrast between regions and Bezdek partition coefficient are improved by 9.301% and 4.127%.

When implementing image segmentation methods based on improved sparse matrix generation for digital image processing, there may be the following potential limitations and challenges: sparse representation and feature extraction processes involve a large number of matrix operations and optimization problems, with high computational complexity. Urban images usually contain a large amount of pixel information, and the processing process requires a large amount of data, which requires high computational resources and storage capacity. For urban images under different scenes and lighting conditions, this method may not achieve ideal segmentation results. In order to overcome the potential limitations and challenges mentioned above, future research can focus on more efficient sparse representation and feature extraction algorithms, reducing computational complexity and time costs using deep learning techniques to learn and extract features from urban images, improving segmentation accuracy and generalization ability.

Acknowledgments

This work is supported by Hainan Provincial Philosophy and Social Sciences Planning Project: “Research on the governance and guidance of public opinion on the prevention and control of major epidemics in Hainan” (NO. HNSK(YB)20-50); the program of Teaching Reform of the Education Department of Hainan Province “Research on the reform of Media Literacy education for Adolescents in Hainan” (NO. Hnjg2021-97).

References

[1] Zhou, X., Zhang, X., Dai, Z., Hermaputi, R. L., & Li, Y. (2021). Spatial layout and coupling of urban cultural relics: analyzing historical sites and commercial facilities in district iii of shaoxing. Sustainability, 13(12), 6877.

[2] Mbaye, J., & Dinardi, C. (2019). Ins and outs of the cultural polis: informality, culture and governance in the global south. Urban Studies, 56(3), 578-593.

[3] M Ceren. (2018). Book review: urban music and entrepreneurship: beats, rhymes and young people’s enterprisewhitejoyurban music and entrepreneurship: beats, rhymes and young people’s enterpriseroutledge, london, 2017, ￡110.00 hbk (isbn: 9781138195462), 160 pp. Cultural Sociology, 12(1), 116-118.

[4] Kourtit, Nijkamp, & Romo. (2019). Cultural heritage appraisal by visitors to global cities: the use of social media and urban analytics in urban buzz research. Sustainability, 11(12), 3470.

[5] Huijsmans, T., Harteveld, E., Brug, W., & Lancee, B. (2021). Are cities ever more cosmopolitan? studying trends in urban-rural divergence of cultural attitudes. Political Geography, 86(2), 102353.

[6] Wang, Q., Mao, X., Jiang, X., Pei, D., & Shao, X. (2021). Digital image processing technology under backpropagation neural network and k-means clustering algorithm on nitrogen utilization rate of chinese cabbages. PLoS ONE, 16(3), 23.

[7] Da-Hai, Xia, S., Song, L., Tao, Z., Qin, Z., & Wu, Z. (2020). Review-material degradation assessed by digital image processing: fundamentals, progresses, and challenges. Journal of Materials Science & Technology, 53(18), 148-164.

[8] Ahmed, A. S., & Omar, A. (2018). Detecting incipient radial deformations of power transformer windings using polar plot and digital image processing. IET Science Measurement Technology, 12(4), 492-499.

[9] Wang, D., Zhao, Y., Rong, L., Wan, M., Shi, X., & Wang, Y. (2019). Expanding the field-of-view and profile measurement of covered objects in continuous-wave terahertz reflective digital holography. Optical Engineering, 58(2), 2-7.

[10] Huang, Y. F., & Wu, H. Y. (2020). Image retrieval based on asift features in a hadoop clustered system. IET Image Processing, 14(1), 138-146.

[11] Yan, Z., Zhang, H., Wang, X., M Gaňová, Lednick, T., & Zhu, H. (2022). An image-to-answer algorithm for fully automated digital pcr image processing. Lab on a Chip, 22(7), 1333-1343.

[12] Oho, E., Suzuki, K., & Yamazaki, S. (2020). Applying fast scanning method coupled with digital image processing technology as standard acquisition mode for scanning electron microscopy. Scanning, 2020(6), 1-9.

[13] Khatri, A. (2018). Assessment of road surface condition using digital image processing. Journal of Engineering Technology, 6(2), 612-625.

[14] Du, Z., Yuan, J., Xiao, F., & Hettiarachchi, C. (2021). Application of image technology on pavement distress detection: a review. Measurement, 184(3), 109900.

[15] Chouhan, S. S., Koul, A., & Singh, U. P. (2018). Image segmentation using computational intelligence techniques: review. Archives of Computational Methods in Engineering, (2), 1-64.

[16] Gibril, M., Idrees, M. O., Yao, K., & Shafri, H. (2018). Integrative image segmentation optimization and machine learning approach for high quality land-use and land-cover mapping using multisource remote sensing data. Journal of Applied Remote Sensing, 12(1), 1.

[17] Tinkler-Davies, B., & Shah, D. U. (2021). Digital image correlation analysis of laminated bamboo under transverse compression. Materials Letters, 283(7), 128883.

[18] D'Haen, J., May, M., Knoll, O., Kerscher, S., & Hiermaier, S. (2021). Strain acquisition framework and novel bending evaluation formulation for compression-loaded composites using digital image correlation. Materials, 14(20), 5931-.

[19] Karthikeyan, N., Saravanakumar, N. M., & Sivakumar, M. (2021). Fast and efficient lossless encoder in image compression with low computation and low memory. IET Image Processing, 15(11), 2494-2507.

[20] Belda, R., R Megías, Feito, N., A Vercher-Martínez, & Giner, E. (2020). Some practical considerations for compression failure characterization of open-cell polyurethane foams using digital image correlation. Sensors, 20(15), 4141.

[21] Valente, J., António, J., Mora, C., & Jardim, S. (2023). Developments in Image Processing Using Deep Learning and Reinforcement Learning. Journal of Imaging, 9(10), 207.

[22] Wang, X., Sun, L., Chehri, A., & Song, Y. (2023). A Review of GAN-Based Super-Resolution Reconstruction for Optical Remote Sensing Images. Remote Sensing, 15(20), 5062.

[23] Jiang, X., Wu, Z., Han, S., Yan, H., Zhou, B., & Li, J. (2023). A multi-scale approach to detecting standing dead trees in UAV RGB images based on improved faster R-CNN. Plos one, 18(2), e0281084.