Research on Accurate Communication Method of Spatial Scene Visual Information Based on Big Data Analysis

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Abstract. Aiming at the problem that the adaptive convergence of noise iteration performance is not fast enough in the traditional spatial scene visual information communication method, a method for accurately transmitting spatial scene visual information based on big data analysis is proposed. The digital image acquisition of the spatial scene is realized by signal filtering processing, then the spatial scene image is transcoded, intercepted and preprocessed, and the spatial scene image distortion correction, image smoothing processing and image segmentation are performed. Finally, through the serial communication method, the visual information of the space scene is accurately transmitted. The experimental results show that the noise iteration performance of the spatial scene visual information accurate communication method based on big data analysis can quickly and adaptively converge compared with the traditional spatial scene visual information transmission method.

Keywords: Big data analysis · Space scene · Visual information · Accurate communication

1 Introduction

A basic spatial scene visual information accurate communication process, including five elements: communicator, recipient, information, media and feedback. The communicator, also known as the source of information, refers to the initiator of the dissemination of this behaviour, and also refers to the person who sends the message in the way of the main action for others. Then in the ordinary social communication behaviour, the communicator can be either an individual or an organization or a group. The recipient, also known as the sink, is the responder and receiver of the information, and is also the audience of the space scene, the target of the communicator [1]. The term "object" does not mean that the recipient is a passive being. On the contrary, it can influence the communicator through feedback activities. Similarly, the recipient can be an individual or an organization or group. In the general communication activities, the communicator and the recipient are not fixed roles, and the conversion of the two roles can be alternated. Information refers to a group of interrelated

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and meaningful symbols that can completely express a certain meaning. The medium is also known as the channel, means or tool of communication. It is the "porter" of information and the link that links various factors in the process of communication [2]. Feedback refers to the respondent's reaction or feedback to the received information, that is, the respondent's reaction to the communicator as described above. In the process of accurately conveying visual information in space scenes, participation or intervention is not only the attributes of the information itself, but also the meaning of the information communicator, the meaning of the information receiver and even the meaning of the information communication medium. Big data analysis studies the accurate communication method of visual information in spatial scenes, which can accurately convey visual information by accurately processing images.

2 Accurate Communication Method of Spatial Scene Visual Information Based on Big Data Analysis

2.1 Space Scene Digital Image Acquisition

Spatial scene digital filtering refers to the process of signal filtering processing, using discrete data analysis techniques and finite precision algorithms to achieve discrete-time linear time-invariant information [3]. Due to the imperfection of the imaging system, the transmission medium and the recording device during the image acquisition process of the space scene, the digital image is contaminated by various noises in different stages during its formation and transmission recording. Spatial scene image filtering is to suppress the noise of the target scene image under the condition of retaining the detailed features of the space scene image. It is an indispensable operation in the spatial scene image preprocessing, and the processing effect will be directly followed by the effectiveness and reliability of image processing and analysis in space scenes [4].

If the contour of the low-frequency component in the digital space scene image is too blurred, the edge extraction results at the contour will be lost, so that the gradient vectors at the lost edge are all turned to the missing point [5]. In this regard, we must first analyze the characteristics of the initial gradient field and GVF field characteristics at the missing edge in the spatial scene image. In order to remove noise, the following energy model is proposed:

$$E_{cp} = \iint \mu|\nabla v|^2 + |W(x,y) \bullet \nabla f|^2 dxdy \tag{1}$$

In the formula, W represents the corresponding map of the missing point, $v(x,y) = [u(x,y), \upsilon(x,y)]$ represents the new vector field [6], which is called the edge preservation GVF (Corner Preserving GVF, CP-GVF) field, ∇f represents the low-frequency edge image f of the gradient space scene image, and μ represents the weighted parameter, There are two types in the energy function formula. The first type $\mu|\nabla v|^2$ represents the transition of the vector field V in the coordinate (x,y). The smaller the change of V, the slower the vector field; The second type $|W(x,y) \bullet \nabla f|^2|V - W(x,y) \bullet \nabla f|^2$ represents the degree of difference between V and $W(x, y) \bullet \nabla f$. The smaller the degree of difference, the closer V and $W(x, y) \bullet \nabla f$ are. So the GVF field is an extended gradient vector field.

Through the processing method of the GVF vector field [7], and then combined with the minimization Eq. (2), the Euler equation of the CP-GVF field can be calculated, as shown in Eqs. (3) and (4).

$$\mu = \Delta u(x, y) - [u(x, y) - W(x, y) \bullet f_x(x, y)] \tag{2}$$

$$\nabla f = \left[W(x, y) \bullet f_y(x, y)\right]^2 \tag{3}$$

In the formula, ∇ stands for Laplace operator, and partial differentiation is expressed by f_x and f_y. The function of removing noise changes is as follows:

$$u = u(x, y, t) \tag{4}$$

$$\upsilon = \upsilon(x, y, t) \tag{5}$$

Because $W(x, y) \bullet f_x(x, y)$ and $W(x, y) \bullet f_y(x, y)$ are both scalar products, the solution to the above equation is similar to the GVF model, and $f_x(x, y)$ and $f_y(x, y)$ need to be multiplied by $W(x, y)$, respectively.

Median filtering was proposed by Turky in 1971. It was originally used for time series analysis of one-dimensional signal processing techniques, and was later used in two-dimensional image processing, and achieved good results in denoising restoration. Median filtering is a nonlinear signal processing technique based on the theory of sorting statistics that can effectively suppress noise. The basic principle of median filtering is to use the value of a point in a digital image or a sequence of numbers to use a point value in a neighborhood of the point. The median value is substituted, so that the surrounding pixel values are close to the true value, thus eliminating isolated noise points [8]. The median filter replaces the pixel value of each point in the image by the median of the pixel values in the corresponding filtered region R. If the number of pixels in the filter area of the median filter is even, then it usually introduces new pixel values. Since the median is a permutation order statistic, it can be understood in a sense that the result is determined by the "majority" of the pixels involved, and the individual particularly high or very low pixel values will not produce too much result. For large influences, they simply push the result forward or backward by a value, so the median is considered a robust quantity.

The basic operations include: decaying candle, expansion, opening and closing operations. It is worth noting that when using morphological filters, structural elements with different shapes, sizes, and directional characteristics should be selected for different purposes. In addition, morphological open and closed operations are idempotent, which means that one filter filters out all structural element-specific noises, and repeating them will not produce new results. Morphological filtering can change the local structure in a predictable way, a property not available in classical methods. Since the morphological operation is image processing from the geometrical point of view of the image, this excellent nonlinear filter can keep the image structure from being ironed while filtering.

2.2 Spatial Scene Image Transcoding Preprocessing

The original image of the spatial scene is usually in YCbCr format, because this method is aimed at RGB format images in the image processing, so it is necessary to use the big data analysis technology to convert the image format. The YCbCr format is one of many color spaces, usually used for continuous image processing of movies, or used in digital photography systems. The YCbCr format is one of many color spaces, usually used for continuous image processing of movies, or used in digital photography systems. In the IMGLIB function library, a function is provided specifically for image format transcoding, which converts YCbCr components into RGB components. The output image occupies 2 bytes per pixel, where R component is 5 bits, G component is 6 bits, B component is 5 bits, and a total of 16 bits, which is exactly 2 bytes. Therefore, before using the image, you need to extract the corresponding RGB component from the 2 bytes of space corresponding to each pixel and convert it to 8bit standard RGB. After the DSP obtains the RGB image to be processed, the image is first intercepted. Because the original image size is 576×720, a total of more than 410,000 pixels, preprocessing all these pixels is not only time-consuming but also unnecessary. In fact, the material is fixed at the position of the image each time, roughly in the photoelectric Near the switch. Quality, which in turn affects the final discriminant result, so this step is particularly important. The method first performs noise removal processing in the preprocessing step. The IMGLIB function library has a median filter function IMG_-median_3 $\times$ 3, which takes a 3×3 pixel matrix and selects the intermediate value as the gray value of the current pixel to perform median filtering.

2.3 Space Scene Image Distortion Correction

In the process of image acquisition of space scenes, due to camera process problems or the wide-angle imaging system itself, the captured images tend to be distorted, causing the captured images to be severely distorted and cannot be directly sorted [9]. Therefore, before performing the sorting process, the source image is corrected for distortion and restored to an ideal state. In order to facilitate the acquisition of real source images, the method adopts a distortion correction method that is simple, efficient and meets real-time requirements. Firstly, the distortion point and the corresponding ideal point are extracted by using the drawn template, and the transformation model is established according to the corresponding coordinate position relationship [10]. When the correction is performed, each pixel point in the distortion image is reduced to an ideal point by the model, and finally passes through the bilinearity. The interpolation calculates the actual gray value of each pixel, and then obtains the complete ideal image. Distortion correction can be roughly divided into three parts, i.e., obtaining control points, obtaining distortion map and ideal point mapping relationship, and bilinear interpolation method for calculating gray value. The first two parts are calculated in advance on the PC. The third part is first simulated on the PC to detect whether the corrected image meets the requirements. Then the distortion corrected code is transplanted into the DSP according to the weights obtained in the first two parts. Realize the real-time operation in the sorting process and complete the correction of the distorted image in the DSP.

In the correction of the distorted image, the control point is manually set in advance. The more the number of control points, the smaller the average error of the calculated result. Therefore, the complete image is used when acquiring the control point, and more control points are set as much as possible [11]. The method adopts a chess board template similar to a chess board. The black and white grid is drawn by equally spaced horizontal lines and vertical lines, wherein the intersection of the horizontal line and the vertical line is set as a control point. When the grid template is placed, the center of the camera's optical axis coincides with the center of the grid. This method first uses the open source Open CV computer vision library on the PC side, and uses the Harris corner detection method to perform corner detection on the checkerboard template image captured by the camera. The actual position of each distortion control point can be obtained very quickly. Because the sides of the mesh are consistent, the ideal coordinates of other control points can be derived from the coordinates of the center point of the image, and the corresponding distortion coordinates can be calculated from the extracted feature point images. The mapping relationship between the distortion point and the ideal point can be established from different aspects. The more common conversion relationship between the corresponding x-axis and y-axis coordinates. Because the radial distortion is mainly considered in the image distortion, the pixel is only distorted in the direction from the center of the optical axis to the pixel, and the angle does not change. The degree of distortion is only related to the distance between the pixel point and the center of the optical axis. Therefore, the method uses the mapping relationship to the center distance of the optical axis to simultaneously measure the values of different pixel points to obtain the mapping relationship between the distortion point and the ideal point, and then use the distortion point and the ideal point. The mapping relationship corrects the distorted image.

2.4 Spatial Scene Image Smoothing

The RGB color scheme encodes colors into a mixture of three primary colors. This scheme is widely used in the transmission, presentation and storage of color images, not only in analog devices such as televisions, but also in digital devices. Under the application of big data analysis technology, many spatial scene image processing and spatial scene image programs use RGB scheme as the internal representation of spatial scene color image [12], and many language libraries use it as a standard spatial scene image representation scheme. The spatial scene color image and the spatial scene gray image are represented in the same way, and are expressed by a series of pixels, but the models used to express the order of the respective color components are different. Each color component in a color image of a spatial scene can be divided into a component arrangement and a packed arrangement method. In the component arrangement, each color component is assigned to a different array of the same size. At this time, the color image of the space scene can be regarded as a set of related intensity images I_R, I_G, I_B, so $\mathrm{I} = <\mathrm{I_R},\ \mathrm{I_G},\ \mathrm{I_B}>$; The RGB component values of the spatial scene color image I at the point $(\mathrm{u},\ \mathrm{v})$ can be obtained by obtaining all three intensity images as follows:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} I_R(u,v) \\ I_G(u,v) \\ I_B(u,v) \end{bmatrix} \quad (6)$$

A packed array of component values representing a particular pixel color is packaged in a single primitive representing the array of images, as shown in Fig. 1. So $I(u,v) = <R, G, B>$, the RGB values of a packed image at points (u, v) can be obtained by accessing the components of the color separately as follows:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} \mathrm{Red}(I(u,v)) \\ \mathrm{Green}(I(u,v)) \\ \mathrm{Blue}(I(u,v)) \end{bmatrix} \quad (7)$$

In the Java Image API, RGB c olor images are applied in a packed arrangement. Each color pixel is represented by an integer value of one bit. There are 8 bits of transparency, the alpha component. The access functions Red(), Green(), and Blue() depend on the specific implementation of encoding the color pixels.

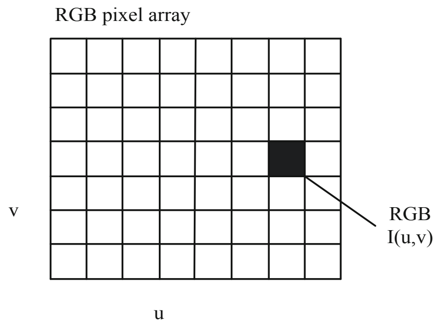

Fig. 1. Schematic diagram of RGB color image pixel storage in Java

In order to decompose the three component values from the packed integer values, appropriate shift and mask operations need to be applied. Since the R, G, and B component values are constructed in the opposite direction, the bit or operation and the left shift operation are applied, and the Oxff is used for the mask operation. This method directly accesses the pixel array, which can improve the program running efficiency. It saves time compared to using Java's image API functions.

The description of the grayscale image of the spatial scene, like the color image of the spatial scene, still reflects the distribution and characteristics of the overall and local chromaticity and brightness levels of the entire image. In the RGB model, if $R = G = B$, the color represents a grayscale color, and the value of $R = G = B$ is called a gray value. Therefore, the spatial scene gray image requires only one byte per pixel to store the gray value, and the gray scale ranges from 0 to 255. The grayscale processing of spatial scene images generally has the following three design schemes:

Weighted average method. According to the importance and other indicators, the three components R, G, and B are weighted and averaged with different weights. Since the human eye is most sensitive to green and the least sensitive to blue, the weighted average of the three components of R, G, and B using Eq. (8) can obtain a more reasonable spatial scene grayscale image;

$$f(i, j) = 0.3R(i, j) + 0.59G(i, j) + 0.11B(i, j) \tag{8}$$

(1). Average method. The luminances of the three components R, G, and B in the color image of the space scene are simply averaged, and the average value is output as a gray value to obtain a grayscale image.
(2). Maximum method. The maximum value of the luminance in the three components R, G, and B in the color image of the space scene is used as the gray value of the grayscale image.

2.5 Spatial Scene Image Segmentation

Image segmentation of spatial scenes is an important step in the accurate transmission of visual information. Therefore, spatial image segmentation based on big data analysis technology is an important image processing link. It can not only compress data in large quantities, but also reduce storage capacity. Simplify later analysis and processing steps to provide a basis for subsequent classification, identification, and retrieval. The image threshold segmentation uses the difference between the target and the background in the image, such as color, geometric shape, spatial texture, etc., and selects one or several suitable thresholds to divide the original image into several disjoint regions to determine the image. Each pixel in the image should belong to the target or the background area, that is, the target is separated from the background image, and then according to the need, whether the corresponding binary image is further generated, and then the segmented image is analyzed. To put it simply, the analysis target is extracted from the background to facilitate subsequent processing of the image.

Pre-processing of image segmentation includes image input, denoising, smoothing, enhancement processing, color space conversion, and the like. Images can be read from a local storage device or read from a remote device via the network and file system. In order to achieve a good segmentation effect and reduce the influence of noise, the general image needs to be smoothed before segmentation, such as using a Gaussian filter for denoising. In some edge-based algorithms, it is necessary to perform Laplacian variation on the edge and enhance the edge information to complete the image segmentation. In addition, different color spaces represent different information of the image. The specific segmentation algorithm always depends on the specific color space, while the general image is stored as (R, G, B), three-channel color information, so it needs to be converted to specific The color space, such as $(R, G, B) \rightarrow (H, S, I)$, $(R, G, B) \rightarrow (H, L, S)$. The core segmentation algorithm is the soul of the image segmentation system and includes all of the various algorithms listed above. The efficiency of the core algorithm determines the efficiency of the entire segmentation system, so it is necessary to ensure the stability of the core algorithm in the system. In practical applications, we need to analyze the running complexity of the core algorithm in time and space, and optimize the algorithm and program to the maximum extent to achieve the optimal use of computing resources. After the image is segmented, there may be many small areas, or the edges of the area are not closed, so it needs to be refined by a specific post-processing algorithm.

2.6 Realization of Accurate Information Transmission

After the vision system has processed the spatial scene image and obtained the sorting result, the result needs to be sent to the control system to realize the accurate communication of the spatial scene visual information. Therefore, it is necessary to select a communication method suitable for the method. Currently commonly used communication methods are: serial communication, parallel communication, wireless communication, and the like. The serial communication only needs a pair of transmission lines to realize two-way communication, which is relatively simple and difficult to be interfered with; the parallel port requires more transmission lines, and the implementation is more complicated, and the 8 channels are susceptible to interference; Wireless communication mainly uses electromagnetic wave signals to propagate information in free space, which is more complicated and can get rid of the dependence on cables in traditional communication. There is no wireless communication requirement in the method, and serial communication is selected as the communication mode between the vision system and the control system for the sake of easy maintenance and low cost.

3 Experimental Results and Analysis

In order to ensure the effectiveness of the accurate communication method of spatial scene visual information based on big data analysis, a simulation experiment is designed. During the experiment, the visual information of a certain spatial scene is taken as the experimental object, and the visual information of the spatial scene is accurately transmitted. In order to ensure the validity of the experiment, the traditional spatial scene visual information communication method is compared with the spatial scene visual information accurate communication method based on big data analysis, and the test results are observed. Spatial scene visual information communication requires noise iteration of spatial scene images to obtain high-definition images to realize visual information transmission of spatial scenes. The basic requirement for noise iterative performance of spatial scene visual information communication methods is fast adaptive convergence.

Figure 2 is the noise average curve of the visual information image of a space scene,As shown in Fig. 2, the noise of the visual information image of the spatial scene is collected. The curve shows that as the number of frames increases, the image noise also increases. When the number of frames is 12, the image noise is 0.54 dB.

Figure 3 is a comparison of the iterative times and the noise average curve of the traditional spatial scene visual information transmission method and the spatial scene visual information accurate communication method based on big data analysis. In Fig. 2,

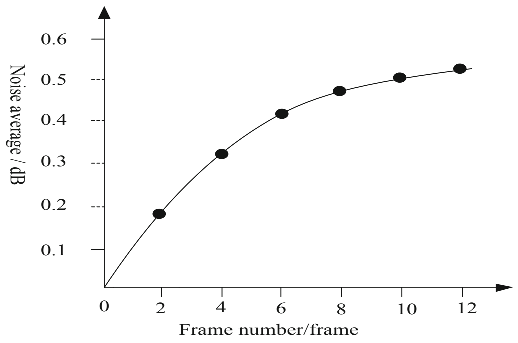

Fig. 2. Noise average curve of visual information image of a spatial scene

the maximum noise average is around 0.54 dB, and the overall upward trend of noise is relatively flat. In Fig. 3, after the processing of the spatial scene visual information transmission method, the image noise is reduced, and the spatial scene visual information accurate communication method based on the big data analysis can perform fast adaptive convergence under the same number of iterations, and iteratively 6 times It can reduce the image noise to 50%, and has better noise iteration performance than the traditional spatial scene visual information transmission method.

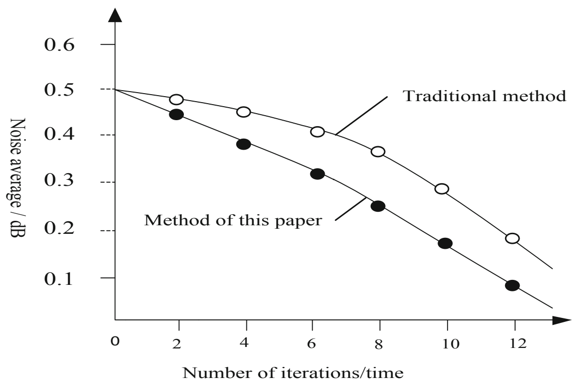

Fig. 3. Comparison of the number of iterations and the noise mean

4 Conclusion

The accurate communication method of spatial scene visual information based on big data analysis can realize the precise processing and accurate communication of spatial scene visual information images. The application of this method will help to improve the communication level of visual information in space scenes.

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