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Image correction technology under computer vision algorithms

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Abstract: This article first introduces the key technologies in image processing, including image denoising, enhancement, restoration, and super-resolution, and elaborates on the application characteristics of computer vision algorithms in image processing. The article focuses on the image correction techniques under computer vision algorithms, especially the distortion correction process and the processing methods of distorted images. I hope to provide reference for the application of image correction technology through this study.

Keywords: Computer Vision; Image Correction; Denoising; Enhancement; Restoration; Super-Resolution

Digital images are affected by various noises, blurring, and degradation during the acquisition, transmission, and storage processes, leading to a decrease in image quality. In order to improve the visual effect and practicality of images, image correction technology has emerged. Computer vision algorithms have broad application prospects in the field of image correction, including image denoising, image enhancement, image restoration, and image super-resolution.

1. Key points of image correction technology

1.1 Image denoising

Image denoising, as the core part of image correction technology, plays a crucial role in improving image quality and subsequent processing effects. Traditional denoising methods are mainly divided into two categories: filters and model-based methods. The filter method has been widely applied in the field of image processing due to its intuitiveness and efficiency. Among them, Gaussian filtering reduces noise by smoothing the image, but its disadvantage is that it may blur the edges and details of the image, leading to the loss of image information. Median filtering is a non-linear filtering method that is particularly effective in removing salt and pepper noise, but it also suffers from the problem of detail loss when processing complex texture images. Compared to filter methods, model-based denoising methods are more complex, but they are also better able to preserve the details and structure of the image. Non local mean filtering is a method that utilizes image self similarity to remove noise by comparing the similarity between image blocks. Its denoising effect is better than traditional local filtering methods, but it requires a large amount of computation. The sparse representation method utilizes the sparsity of the image in the transformation domain and removes noise by solving optimization problems, which can effectively preserve the edge and texture information of the image. However, it also faces the problem of high computational complexity.

1.2 Image Enhancement

Image enhancement is a key technology in digital image processing that aims to optimize the visual representation of images, ensuring clearer image content and sharper contrast. In daily applications and scientific research, image enhancement has immeasurable value in extracting key information and improving user experience. In traditional image enhancement techniques, histogram equalization is a classic and effective method. It improves the contrast of the image by redistributing the grayscale level of the image, making the histogram of the image more uniform. However, this method may introduce unnecessary noise when processing certain images, which can affect the overall quality of the image.

In order to overcome this problem, adaptive histogram equalization technology has emerged. This method can adjust the parameters of histogram equalization based on the characteristics of local regions in the image, thereby enhancing image contrast while minimizing the introduction of noise. However, adaptive histogram equalization is not foolproof, as it may cause certain distortions during the processing, especially at the edges and details of the image. Therefore, although image enhancement technology can significantly improve image quality to a certain extent, it still needs to be carefully selected and processed in practical applications to avoid introducing unnecessary noise and distortion, ensuring that the enhanced image is both clear and natural.

1.3 Image Restoration

Image restoration technology is an important challenge in the field of image processing, with the goal of restoring the information of the original image as much as possible from degraded or damaged images. This restoration process has a wide range of applications in many fields, such as medical imaging, security monitoring, and historical document restoration. Traditional image restoration methods, such as inverse filtering and Wiener filtering, are based on modeling the process of image degradation. The inverse filtering method attempts to restore images by reversing the degradation process, but this method is very sensitive to noise and may lead to unstable restoration results. Wiener filtering is a more robust method that considers the impact of noise and attempts to find a balance between suppressing noise and restoring images. However, both methods heavily rely on accurate estimation of the degraded model, and if the model is not accurate, the restoration effect may be greatly compromised.

1.4 Image super-resolution

Image super-resolution technology is a cutting-edge technology in the field of digital image processing, which aims to reconstruct high-resolution images from low resolution images to display more details and information. This technology has broad application prospects in many fields, such as medical imaging, security monitoring, multimedia entertainment, etc.

Traditional image super-resolution methods mainly include interpolation and reconstruction. Interpolation methods, such as nearest neighbor interpolation, bilinear interpolation, etc., estimate the value of unknown pixels by utilizing the information of known pixels, thereby achieving an improvement in image resolution. However, this method often produces jagged effects on the edges and details of the image, leading to a decrease in image quality. The reconstruction method attempts to restore high-resolution images by establishing the relationship between low resolution images and high-resolution images. This method can reduce the aliasing effect to a certain extent, but the computational complexity is high, and for complex image content, the reconstruction effect is often not ideal, which may introduce distortion and artifacts.

Therefore, although traditional image super-resolution methods can improve image resolution to a certain extent, they still have many shortcomings in visual effects and computational efficiency. In order to overcome these problems, researchers are constantly exploring new super-resolution technologies in order to reduce computational complexity and better meet the needs of practical applications while maintaining image quality（As shown in Figure 1）.

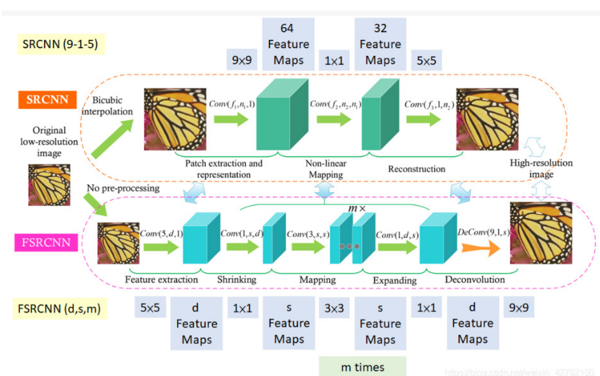

Figure 1 Image super-resolution method

2. Characteristics of image processing technology under computer vision algorithms

Through advanced algorithm design, this technology enables computers to process and analyze large amounts of image data in a short period of time, achieving high accuracy in image recognition, classification, and target tracking. This efficient processing method greatly enhances the scope and practicality of image applications. In addition, computer vision algorithm image processing technology has demonstrated strong robustness. In practical applications, images are often affected by various factors such as lighting, angle, occlusion, etc. However, excellent computer vision algorithms can still maintain stable performance in these complex environments, ensuring the accuracy and reliability of image processing.

With the continuous increase and update of data, computer vision algorithms can self learn and optimize, gradually adapting to new image features and processing needs. This adaptive ability enables computer vision systems to quickly respond to various changes and maintain optimal working conditions. On this basis, computer vision algorithm image processing technology also has good scalability. With the continuous improvement of hardware performance and the continuous development of algorithms, the types and complexity of images that computer vision systems can process are also increasing. Both two-dimensional images and three-dimensional models, as well as static images and dynamic videos, can be effectively processed and analyzed through computer vision technology.

3. Image correction techniques under computer vision algorithms

3.1 Image distortion correction process

In computer vision, images captured often experience distortion due to factors such as camera optical characteristics and mechanical installation errors. The purpose of distortion correction is to restore the original scale and shape of the image for subsequent processing and analysis. The process of distortion correction mainly includes three steps: establishing a distortion model, parameter estimation, and image correction. Firstly, based on the distortion types of the camera (such as radial distortion, tangential distortion, etc.), establish corresponding mathematical models to describe the impact of distortion on the image. Then, by shooting specific patterns such as calibration boards, the parameters of the distortion model are estimated using algorithms. Finally, the original image is corrected based on the estimated parameters to obtain a distortion free image. The key to this process lies in the accuracy of the distortion model and the accuracy of parameter estimation. Different cameras and shooting environments may require different distortion models and parameter estimation methods. Therefore, in practical applications, it is necessary to choose appropriate correction methods and algorithms based on specific situations.

3.2 Processing of Distorted Images

For images that have already undergone distortion, computer vision algorithms provide multiple processing methods. The purpose of these methods is to restore the original information of the image as much as possible, improve the quality and usability of the image. A common processing method is correction based on image registration. This method first selects a reference image with no distortion or less distortion, and then registers the image to be corrected with it. Through transformation and interpolation operations, the two images are geometrically aligned. In this way, the proportion and shape information of the reference image can be transmitted to the image to be corrected, achieving distortion correction.

4. Program based on computer vision algorithm image processing technology

Firstly, importing the necessary image processing and algorithm libraries is the first step in program design. OpenCV is a widely used open-source computer vision library that provides rich image processing functions and algorithms. By introducing the OpenCV library, it is convenient to perform operations such as image reading, display, transformation, and processing. In addition, other related libraries can be imported according to specific needs, such as NumPy for numerical calculations and matplotlib for image display. Then, program design involves reading the image to be corrected and performing preprocessing. The preprocessing operation aims to improve the quality and stability of the image, laying a solid foundation for subsequent correction processing. Common preprocessing operations include grayscale, denoising, contrast enhancement, etc. Grayscale conversion is the process of converting color images into grayscale images, simplifying image information and reducing computational complexity. Denoising is the process of using filtering algorithms to remove noise from an image and improve its signal-to-noise ratio. Contrast enhancement is achieved by stretching the grayscale range of an image to enhance its contrast and make the image clearer.

After completing the preprocessing operation, perform distortion correction on the image based on the selected distortion model and parameter estimation method. The selection of distortion models and parameter estimation methods is directly related to the effectiveness of correction. Common distortion models include radial distortion, tangential distortion, etc., while parameter estimation methods can be estimated using algorithms by capturing specific patterns such as calibration plates. During the calibration process, complex mathematical operations and image processing techniques such as matrix operations and interpolation algorithms are required. These operations and processing require the use of professional algorithm libraries and tools to ensure the accuracy and efficiency of calibration. When saving images, different file formats and image quality can be selected to meet different application requirements. Common file formats include JPEG, PNG, etc., while image quality can be controlled by adjusting parameters such as compression ratio. When displaying images, graphical interface libraries or image processing software can be used for display, for subsequent analysis and application.

5. Conclusion

In short, the application of computer vision algorithms has taken image processing technology to the next level. Through advanced algorithm design, computers can efficiently process and analyze large amounts of image data in a short period of time, demonstrating extremely high accuracy and robustness in areas such as image recognition, classification, and target tracking. The correction technology of images has made significant progress in computer vision algorithms. Whether it is distortion correction or image processing, computer vision algorithms provide various efficient methods and processes. By writing programs, we can achieve automation and batch processing of images, greatly improving processing efficiency.

References

[1]Rao Perumalla Srinivasa; Yedukondalu Kamatham.Hardware implementation of digital image skeletonization algorithm using FPGA for computer vision applications[J].Journal of visual communication & image representation,2019(Feba):140-149.

[2]Qin Fang;Zeng Weijia;Ruijie Liu;Xuming Lu.Research on Intelligent Image Recognition Technology Based on Equalization Algorithm[J]. Journal of Physics: Conference Series. Volume 1748 , Issue 4 . 2021. PP 042065.

[3]Dai，Kankan，Zhao，Jianwei，Cao，Feilong.A novel algorithm of extended neural networks for image recognition[J]. Engineering Applications of Artificial Intelligence,2015(juna):57-66.

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