Application of Computer Image Processing and Recognition Technology

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Abstract

Computer image processing and recognition technology is a field that covers multiple disciplines such as computer science, electronic engineering, and mathematics. It is committed to developing algorithms and technologies to process and understand digital images. In image processing, the key is to extract features from the image, which helps to understand the content of the image. The extracted features can include color, texture, shape, edges, etc. Based on the extracted features, image recognition algorithms can classify images into different categories. With powerful computing capabilities and a wide array of tools, coupled with the rapid advancement of digital image acquisition technology through long-term practice and development, image processing and recognition technology has emerged as a crucial branch of computer vision. It has progressively evolved into a pivotal tool for addressing intricate problems and enhancing quality of life. At present, image processing and recognition technology still face a series of challenges, such as target recognition in complex scenes, processing large-scale image data, and ensuring privacy protection. This article analyzes the principles of computer image processing and recognition technology and explores the optimization of this technology in specific application processes.

Keywords

Computer image processing, recognition technology, data, model

Introduction

With the improvement of computer performance, the progress of image acquisition equipment, and the development of artificial intelligence technology, image processing, and recognition have been widely used in various fields, such as medical imaging, security monitoring, automatic driving, face recognition, etc., has brought social convenience and innovation, in most application areas, through the processing of medical image, can realize the early diagnosis of disease and more accurate treatment plan [1]. The application of computer image processing and recognition technology has profoundly affected many fields and brought great economic and social benefits to society. However, with the continuous expansion of application scenarios and the deepening of technology, there are still a series of challenges, such as poor image quality, insufficient algorithm robustness, and other problems, and more in-depth research and technological innovation are needed to promote computer image processing and recognition technology to better serve human society.

1. Principles of computer image processing technology and recognition technology

1.1 Principles of computer image processing technology

Computer image processing technology is a field of research on how to analyze, process, and interpret digital images.
The basic principle involves many key steps such as image acquisition, preprocessing, feature extraction, representation and description, classification, and identification [2].

Image acquisition is the basis of this technology. Visual information is obtained through various sensors (such as cameras), and the actual scene is mapped into digital images. After collecting the data is obtained, the preprocessing stage aims to denoise, smooth and enhance the image, so as to improve the stability and reliability of subsequent processing. In the feature extraction stage, the algorithm abstracts the image information into more representative feature vectors by detecting local or global features in the image, such as edge, texture, color, etc. In the subsequent image implementation stage, the image information is expressed more clearly by selecting the appropriate representation form, such as the grayscale histogram, the edge graph, etc. In this process, various mathematical tools and transformation techniques, such as Fourier transform and wavelet transform, are widely used to lay the foundation for further processing. In the stage of classification and recognition, the image processing technology analyzes and classifies the extracted features through machine learning and pattern recognition, so as to realize the intelligent cognition and understanding of images. In this step, common algorithms include support vector machine (SVM), convolutional neural network (CNN), etc., which train the model to have the ability to identify and classify new images.

In addition to the above basic steps, computer image processing technology also involves many advanced technologies, such as image segmentation, object tracking, 3D reconstruction, etc. [3]. Image segmentation involves dividing the image into several non-overlapping regions, with each region containing specific semantic information. This process provides a foundation for more in-depth analysis. Target tracking focuses on tracking the target of interest in the video sequence, and needs to overcome the challenges brought by complex scenes such as target change and occlusion. In the three-dimensional reconstruction, the image processing technology restores the three-dimensional structure of objects through multi-perspective image information, which provides key support for virtual reality, medical imaging, and other fields.

1.2 Principles of computer image recognition technology

Computer image recognition technology is a research based on the field of computer vision, aiming to enable the computer system to simulate and understand the process of human image perception and realize the automatic recognition and classification of targets in the image. The principle of computer image recognition technology covers many key aspects, including feature extraction, model training, classification decision-making, and so on.

First of all, feature extraction is the basis of image recognition technology, the system through mathematical and statistical methods from the image to extract representative features, related features can be the edge of the image, texture, color, and other high-level abstract information, it can also be through the convolution neural network (CNN) and other deep learning model learned more abstract representation, feature selection, and extraction quality is directly related to the subsequent model performance and generalization ability [4]. Secondly, the model training is a key step in the image recognition technology. The training procedure typically uses an image dataset with labels, where each image is associated with the corresponding category label. Convolutional neural network in deep learning is one of the most widely used models at present. Through back propagation algorithm and gradient descent optimization algorithm, the model can accurately classify the image by constantly adjusting the weight parameters. The training phase of the model requires a large amount of computational resources and data while needing to prevent overfitting to guarantee the generalization ability of the model on new data. Finally, after the model training, the image recognition system enters the classification decision stage. When the system receives a new unlabeled image, the computer classifies the image and outputs the predicted category labels. This decision-making process can be based on rules, traditional machine learning algorithms, or a neural network model in deep learning. With the comprehensive development of deep learning technology, especially the successful application of convolutional neural networks, the image recognition system has achieved remarkable results in large-scale image data.

2. The Application strategy of computer image processing and recognition technology

2.1 data preprocessing

Data preprocessing in computer image processing plays a vital role in recognition technology, it is the basis of guarantee model training and application performance, data preprocessing includes the quality and integrity of the original image, the need to accurately check the image resolution, brightness, contrast, can reduce noise in the subsequent
processing, ensure the consistency of the input data. In addition, for the problems of outliers, missing values, or deformation in the image, the corresponding repair and interpolation means are helpful to improve the reliability of the data.

On the one hand, data preprocessing also includes the process of image standardization and normalization, need to zoom image pixel value to the same range, help to eliminate the scale difference between different images, ensure the model in training and application has better stability, the standardization of data also helps to accelerate the model convergence process, make the training more efficient, effective normalization is further ensure the unified distribution of the image, is conducive to the performance of some sensitive to the input data model\cite{5}. Data preprocessing, on the other hand, involves image enhancement technology, aims to improve the quality and clarity of the image, the need for image sharpening, denoising, enhanced contrast, highlighting the key information in the image, enhance the characteristics of the image, contribute to the model to better capture the useful information, improve the accuracy and robustness of image recognition.

In addition, data preprocessing also involves efficient data sampling and enhancement methods when processing large-scale datasets. Through reasonable sampling strategies, we ensure that the model can fully learn the differences between different classes during training and prevent model bias due to class imbalance. At the same time, data enhancement techniques such as random rotation, translation, and scaling can be used to generate more training samples and improve the generalization ability of the model.

2.2 Optimization of characteristic engineering

The optimization of feature engineering is a key step in computer image processing and recognition technology, which directly affects the performance and generalization ability of the model. Specifically, the optimization feature engineering needs to choose the appropriate feature extraction method, including the traditional low-level feature extraction based on edge, texture, and color, as well as automatic feature learning based on deep learning, on the basis of deep learning technology through hierarchical feature extraction and abstraction, can capture a higher level of semantic information, but also more expensive in computing resources and data requirements.

In the feature selection process, by evaluating the importance and relevance of features, the most representative and differentiated features are selected, to reduce the influence of redundant information and noise, and improve the stability and generalization ability of the model. In terms of feature dimension reduction, principal component analysis (PCA), linear discriminant analysis (LDA), and other methods are adopted to map the feature space of higher dimensions to the subspace of lower dimensions, which helps to reduce the model complexity and computational cost, while preventing overfitting. Moreover, when processing complex and variable image data considering feature distribution differences between different image categories and targeted feature extraction and model tuning strategies between different image categories. At the same time, with the changes in data and tasks, feature engineering also needs to be constantly iterated and optimized to adapt to new application scenarios and requirements, and maintain the efficiency and adaptability of the model. At the same time, different application scenarios and tasks are selected for appropriate feature representation methods and model structures, making full use of domain knowledge and prior information to improve the effect and practicability of the model.

2.3 Algorithm selection and model construction

In computer image processing and recognition technology, the selection of algorithm should be based on the complexity of the problem, the data scale, and the characteristics of the nature, of the traditional image processing tasks, such as edge detection, filtering, etc., which can be selected based on rules or traditional machine learning methods, such as support vector machine (SVM), random forest, etc. For more complex image recognition tasks, especially on large-scale data sets, deep learning models, especially convolutional neural network (CNN), recurrent neural network (RNN), etc., usually can better capture abstract image features and show excellent performance.

In deep learning, different network architectures, such as ResNet, Inception, MobileNet, etc., are suitable for applications with different scale and real-time performance requirements. In addition, considering the diversity and dynamics of the data, transfer learning technology can also be fully applied. By fine-tuning on the basis of the pre-training model, we can accelerate the convergence of the model and improve the identification accuracy. While in the model construction, adjusting the hyperparameters of the model is also a key step to optimize the performance. The adjustment of hyperparameters such as learning rate, regularization term, and batch size directly affects the convergence speed and generalization ability of the model, and finds the optimal combination of hyperparameters.
through cross-validation, which helps the model to achieve better results in practical application. At the same time, in order to improve the interpretability and robustness of the model, the integrated learning method is often applied to image processing and recognition. It can combine the prediction results of multiple models, such as voting, stacking, etc., which can make up for the deficiency of a single model and improve the overall performance.

2.4 System integration and deployment

On the one hand, in system integration, it is necessary to organically combine the image processing and recognition technology with the whole system to ensure that it works together with other components. This includes seamless docking with hardware devices, such as cameras, sensors, etc., and good integration with software systems, such as data storage, user interfaces, etc. At the same time, the reasonable design of the system architecture and modular structure is helpful to improve the maintainability and scalability of the system. On the other hand, the deployment stage of the system needs to select the appropriate deployment mode according to the application scenario. Cloud deployment is suitable for scenarios that are insensitive to computing resource requirements and require remote access, while edge and embedded systems are more suitable for applications that require high real-time requirements or require processing locally on the device [6]. Rational selection of deployment methods helps to optimize system performance and resource utilization efficiency, providing more flexible and customizable solutions.

In the process of system integration and deployment, the security and privacy protection of the system should also be considered. Using encryption technology, access control strategy, and other means to ensure that the image processing and recognition technology can operate safely and reliably in the application, to prevent potential threats and attacks. At the same time, for applications involving personal privacy, privacy policies should be formulated, and appropriate measures should be taken to protect and anonymize user data, so as to protect users' privacy rights and interests.

3. Conclusion

To sum up, in the application field of computer image processing and recognition technology, it is very important to deeply consider the strategies of data preprocessing, feature engineering, algorithm selection and model construction, model training and optimization, etc. With carefully designed data preprocessing, we can improve image quality, clean noise, and provide a reliable data basis for subsequent processing. In terms of feature engineering, the selection of appropriate feature extraction and dimension reduction methods, as well as optimizing feature selection, helps to improve the model's ability to abstract and express image information. In the algorithm selection and model construction, the appropriate algorithm and model structure are selected according to the complexity of the problem and the characteristics of the data, and the performance and adaptability of the system are improved through careful parameter adjustment and model integration. Finally, in the model training and optimization stage, through high-quality marker data, appropriate loss function and evaluation indicators, as well as timely learning rate adjustment and regularization, the effective training and optimization of the model are realized, which provides a scientific and reasonable method for realizing accurate and efficient image analysis and identification.

References