Digital Image Processing Technology and Application in Matlab

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Abstract: Digital Image Processing (DIP) is one of the key technologies in robot vision, at the beginning of this paper the definition of digital image and its fundamental type are introduced briefly, then some common methods of DIP are summarized in detail, its relative merits and applications are concisely described. Next the advantage in image processing of MATLAB is discussed, its practical application is summarized by technology field and its arithmetic or the system is evaluated shortly. In the end conclude the paper and put forward to a DIP system based on MATLAB, preparing for robots vision calculation.

1. Introduction

Image are classified into two categories: one is analog image produced by the continuous change of infinitely dense points, such as optical image and electron image. The other is digital image sampled and saved by computer. Image processing has become a practical technology in recent years due to the rapid development of the computer technique [1]. Image processing is usually referred to digital image processing in the literature if there is no special explanation.

Digital image processing technology is a technology that samples continuous signals into discrete signals through signal acquisition and obtains effective messages from them by computer calculation. It has widespread applications in scientific research, industrial and agricultural production, road travel, people's livelihood & national defense and many other fields. This paper introduces related content of the digital image processing, and summarizes several areas of image processing application examples, at the end plan on designing an image processing platform, to lay a foundation for robot vision image processing.

2. Digital Image Processing Technology

2.1 Image Processing

Due to the constraints of large data, immature technical means and high processing difficulty, the image processing technology did not get good application effect at the beginning. It was the rapid development of computer technology that led to the development of image processing. With the development of science and technology, there are few users who use film to obtain images except for specialized persons. Instead, they rely on digital cameras, industrial cameras, high-speed cameras, scanners or other mobile devices. The images obtained through this way are all digital images. The common image processing process is shown in figure 1.

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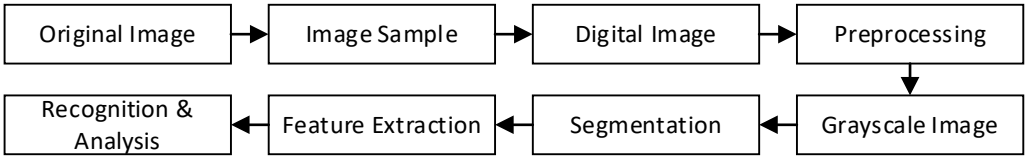

Fig.1 Process of Image Processing.

2.2 Purpose of Image Processing

Digital image processing technology was originally designed to improve the quality of the image, eliminating the undesired parts of the image for people to observe and recognize. With the great progress of society and the change of the life, image processing has gradually changed from improving the visual effect to a more profound level. First, the image takes up a lot of resources when it is transmitted or saved, and then develops compression codes to save storage space and improve the transmission of information. Second, according to the feature information contained in the image, the computer can recognize the picture more quickly and accurately, which provides convenience for machine vision and machine identification. Third, from the perspective of information security, image processing can also be used for image encryption to prevent the disclosure of privacy and protect the security of national or personal information [2].

2.3 Image Processing Technology

2.3.1 Preprocessing

Image preprocessing includes image operation and image transformation. Image operation describes the transformation of an image from one state to another, including the following aspects:

(1) Pixel operation: the most basic operation, calculating the value of each pixel to correct the image display.

(2) Algebraic operations: operations between arrays, can be used for their own arithmetic operations, can also be used for complex image processing preparations.

(3) Geometric operation: the process of pixels moving in the image.

(4) Logical operations: including bit and, bit or, bit complement, bit xor and bit shift.

Image transformation, one of the main means of image processing, solve the problem of large computation or inability to process in the spatial domain, mainly including:

(1) DFT: the most important and widely used transform in signal processing. The signal is transformed from the time domain to the frequency domain according to some transformation relation, and then processed in the frequency domain after transformation.

(2) DCT: DCT is similar to DFT, but only uses the real number part. Because of its fast computation, DCT is widely used in the field of image compression and coding.

(3) DWT: DWT is a great breakthrough for DFT. It has good local characteristics and energy concentration characteristics in both time domain and frequency domain, and solves many problems that cannot be solved by DFT in image compression and segmentation.

2.3.2 Image Enhancement and Restoration

Proper image enhancement can preserve the features of the image while denoising, make the image clearer and more obvious, and provide more accurate information for the observer. Image enhancement methods mainly include:

(1) Gray level transformation enhancement: enhance the image by improving the contrast of the image, make the image pixel value evenly distributed or meet a certain distribution state to enhance the image.

(2) Spatial filtering enhancement: calculate the gray value of each pixel in the spatial domain to enhance the image.

(3) Frequency domain filtering enhancement: the image is transformed to frequency domain by some kind of transformation, and the data is reversely transformed back to the original spatial domain after being processed by the proprietary properties of this frequency domain.

(4) Color enhancement: according to the visual characteristics of human eyes, the difference

between different objects is highlighted by color synthesis, color display or color distribution.

The factors of image quality are various, and it is difficult to get satisfactory restoration without considering the reasons. While restoring the details of the image, it is inevitable to mix in the noise, while removing the noise, it will also blur the edge to some extent. Generally, the degradation mechanism of the image should be analyzed. However, this degradation mechanism is more complex, and the approximate degradation function is used to reproduce the original image in practice. The restoration methods include inverse filtering restoration, wiener filtering restoration and blind DE-convolution filtering restoration.

2.3.3 Image Compression Code

The image itself takes up a large amount of space without processing, which takes up a lot of resources to save, process or transfer, so it should be processed accordingly. Since the original image data contains a large amount of redundant information, these redundant information can be reduced or even eliminated by technical means, and the image can be reconstructed with as little data as possible under the desired conditions. This is image compression coding research.

Compression codes are lossless and lossy. Lossless coding is a compression method that preserves all data. Common algorithms include arithmetic coding, Huffman coding, stroke coding, etc. The redundancy of coding in the image is removed, and the image compression effect is better for images with roughly the same color. The image with lossy coding has a certain degree of distortion when it is restored, but this distortion is within the acceptable range, such as removing some color information redundancy that cannot be detected by human eyes. The commonly algorithms are predictive coding, subband coding, statistical block coding and fractal coding, etc. Because of good compression ratio, they are widely used in practice, such as JPEG image format.

2.3.4 Image Morphology

Mathematical morphology algorithm can process images in parallel because of its parallel structure. Its basic operations include expansion, corrosion, open operation and close operation. When processing binary images, morphology is mainly used to extract the image components required. Based on four basic operations, practical algorithms can be combined or derived, such as boundary extraction, connected component extraction, convex hull, regional skeleton morphology algorithm. When processing grayscale image, four basic operations can be used to establish the grayscale morphological algorithm, such as morphological gradient operation boundary extraction algorithm, texture region segmentation algorithm, smoothing and sharpening algorithm. These algorithms are useful in areas such as image compression, restoration, segmentation, edge detection, texture analysis or shape recognition.

2.3.5 Image Segmentation

An image has both the “efficient” information part and “invalid” background part, sometimes we need to extract the image of some particular object, according to the unique properties of the object, these properties can be gray level, texture, color, or area, etc., this is the image segmentation. The commonly segmentation methods are:

(1) Edge detection segmentation: images segmentation by detecting the boundaries of different parts, it is essentially an algorithm to extract the dividing line between the desired object and the background.

(2) Threshold segmentation: integrate the pixel set according to the gray level, the selection of threshold can be diverse, with the same attributes in each region, it is used widely, such as binary segmentation.

(3) Region segmentation: it solves the problem of limited selection of threshold segmentation, including region growing method, splitting and merging method.

With the advancement of theory, some scholars have added the research results of fuzzy theory, genetic algorithm, wavelet transform in image segmentation, formed the joint specific method and the modern segmentation method for specific images.

2.3.6 Image Description and Recognition

The final expectation of image processing is to have an objective description of the image and to identify it, which involves the field of pattern recognition. Its key point is image feature extraction. After image preprocessing with one or more of the aforementioned operations, features are extracted from the image to form an objective description of the image. If we pay attention to shape features, we can use external representation; if we pay more attention to color, texture and other features, we can use internal representation. More often both approaches are taken. The descriptors that represent the essential differences among objects are captured for feature extraction, so as to obtain the cognition of the computer about the image, and then the image is compared, recognized and classified. The commonly used pattern recognition methods include decision theory, structure and statistics.

3. Application in Matlab

3.1 Industrial Manufacture

Due to the special production environment and rough printing condition in some fields, the material code on materials is difficult to distinguish, which brings trouble to the scheduling management of enterprises. In order to eliminate the disadvantages of manual operation and realize the automatic access management of materials, DIP technology is also very useful in the field of automatic identification of material code. Relevant scholars of Southeast University designed a plate number recognition system based on digital image processing to meet the needs of automatic identification of steel plates in enterprises. The system has an accuracy of 99.02% and is well applied under special working conditions. Image processing also has a good performance in the detection of non-ferrous metals. Copper ore are variety, complex composition, its nature and state are obvious differences. It is difficult to rely on manual detection. Computer image processing and recognition technology has effectively solved the problems caused by the complex composition of copper ore, and obtained more accurate detection results in practice [3].

3.2 Traffic Control

The committed step of intelligent traffic system is license plate automatic recognition, which is also based on the increasingly mature image processing technology. Machine vision and image processing is used to replace human vision to analyze images and recognize license plate numbers. Our country has a large number of automobiles, the combination of Chinese characters, letters, Arabic numbers, special symbols and colors results in diverse and complex license plates. It requires high capacity and is difficult using high-level language such as C, C++ for image processing. It can reduce the difficulty of programming and trouble of maintenance and has a quick distinguish based on greater computing power and various image processing function libraries in MATLAB. The license plate recognition based on MATLAB is sensitive and fast, with a good application effect, and will play more and more roles in the growing environment of various models [4-5].

3.3 Monitor Security

Facial features are the inherent characteristics of a person, the developed individual face can remain unchanged for a long time and the facial features are different between individuals, which is a powerful proof of identity. Because of its advantages of convenience and friendliness, passive recognition and easy acceptance, the application of face recognition and judge identity has become one of the hot spots in the field of monitoring and security at home and abroad. Currently, the mainstream method of face recognition is the principal component analysis subspace method proposed by Kirby and Turk et al. to solve the non-compactness of high-dimensional vectors and the difficulty and complexity of computational analysis. The successful methods include linear discriminant analysis, principal component analysis, vector quantization and independent element analysis. Technology based on 2D recognition has been gradually improved and good results are

obtained in related applications. However, when there are significant changes in posture, expression, makeup or lighting, the recognition effect is not ideal. In recent years, the academic community has started to study the 3d face recognition technology, with the help of such means as binocular camera to obtain the depth of field, then construct the 3d model for matching, and based on the powerful mathematical calculation ability of MATLAB, make the face recognition technology develop towards a more accurate, efficient and convenient direction [6].

3.4 Artificial Intelligence

Due to the large population base in China, there are also a large number of elderly people and people with disabilities. Most people cannot understand sign language. Traditional paper-pen communication not only takes time and effort, but also requires great patience. As a result, these disabled people have great communication barriers when communicating with the outside world in life, which can easily lead to self-abasement and even revenge on the society. In this context, gesture recognition and facial expression recognition based on image processing with the help of computers, smart phones or other smart wearable devices came into being. Some scholars have established the gesture model by using MATLAB, identified the meaning of gesture by means of classification and recognition, and then displayed the text with the help of human-computer interaction equipment, so that the goal of this field in the future is to achieve rapid, convenient and barrier-free communication [7].

4. Conclusion

With the help of computer technology, digital image processing technology can realize the complex operation of image processing, and its advantages are high precision, wide application, high flexibility and strong reproducibility. It has been widely used in many fields and industries. With the improvement of digital image processing technology, it is also limited by some technical conditions, such as the progress of mathematical theory, the progress of computer technology and performance, and the development of related hardware and software.

This paper introduced the current related technology and relevant application of digital image processing in MATLAB. With the introduction of new theories, new algorithms, new equipment in computer hardware, communication technology and other fields of science and technology, the application fields of digital image processing will be broader in the future, and the development direction will be technology standardization, high-speed processing, equipment chipping and intelligence. The next step of the project is to design an image processing system based on MATLAB, to provide a feasible scheme for robot vision and the follow-up work.

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