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Research Progress of Digital Image Processing Technology: An Overview

Aruna Bandi[1] *, Dr. B Rama Reddy*[2]
[1]Ph.D. Scholar, Computer Science & Engineering Department, Kakatiya University, Warangal, Telangana, India.
[2]Head Computer Science & Engineering Department, Kakatiya University, Warangal, Telangana, India.

Abstract. Digital image processing technology has gone through rapid development and is extensively applied in daily life and production, with the rapid development of modern information technology. It plays an inestimable role in remote sensing, medicine, recognition and other fields. This paper briefly introduces the basic concept of digital image processing, summarizes and analyses the commonly used digital image processing technology and the latest scientific research achievements from four aspects, and puts forward the future development direction of digital image processing. In the future, it will pay more attention to artificial intelligence algorithms and achieve better processing results by optimizing the logical structure. By using the simplified image algorithm, the application scope of digital image processing will gradually expand, and will develop in the direction of miniaturization, intelligence, and convenience.

Keywords: Digital Image Processing, Artificial Intelligence, Image Algorithm, Overview.

1. Introduction

In recent years, digital image processing has burgeoned with the growth of computer and mathematics, as well as the growth of application needs in medicine, the military, agriculture and animal husbandry. This paper expounds the research background, present developing status and application of digital image processing, and analyzes the latest technologies of digital image processing from four aspects: remote sensing technology, medical observation, human feature recognition, and intelligent transportation. Finally, the development trend of digital image processing can be briefly analyzed, and the developing direction of digital image processing technology is expressed. This paper is beneficial to understand the latest technology and development trends in digital image processing, and can promote in-depth research of this technology and apply it to real life.

2. Digital image processing Technology

Digital image processing technology is a method to transform image signals into digital signals, and then use computer processing to achieve some purpose of image modification. The rapid advancement of computing and mathematics has led to improvements and perfections in digital image processing technology. Image quality enhancement, picture analysis, and image reconstruction are its three components. Because it can only handle linear processes, optical image processing can only be applied in a limited number of scenarios. Digital image processing is also capable of realizing nonlinear processing, allowing for the representation of all operations on mathematical formulas as well as logical linkages on image processing procedures. Now, higher-level image processing can be realized by artificial intelligence algorithms such as neural networks.

Digital image processing is mainly composed of the following four aspects. First, image digitization, which is the basic step before the computer processes the image, is to transform the real image into a storage format that the computer can accept. The image digitization process is divided into two steps: sampling and quantization. Sampling refers to the process of changing continuous quantities in the time domain or space domain into discrete quantities, while quantization refers to the process of approximating the continuous values of signals to a limited number of discrete values. Second, the correlation of digital images is one of the two fundamental characteristics of digital image compression. In other words, there is frequently a significant relationship between adjacent pixels and their corresponding pixels in adjacent frames. Eliminating or reducing these correlations will also cause the reducing of the redundancy in the image information, which means it realizes the compression of digital images. The other one is human visual psychological features. Human vision is insensitive to weak in color resolution and abrupt changes in edges. Using these properties can properly reduce the accuracy of coding in the relative parts, which cause that people do not experience the decline of image quality visually, so as to realize the purpose of digital image compression. Third is image enhancement, which uses different kinds of mathematical means and transformation means to improve the contrast ratio and clarity of the image, so that, for human visual characteristics or machine recognition systems, the processed image is more suitable by using this method. Fourth, image segmentation is to separate the image into multiple specific regions with unique properties, each of which is a continuous set of pixels. In the development of digital image processing, there are many factors that restrict its development.

For example, digital image processing has a large amount of information, occupies the computing speed of the computer, and has certain requirements for storage capacity. At the same time, it is difficult to process the frequency band. Because the development of digital image processing has the characteristics of high-frequency band images, it is particularly critical in frequency band processing, storage and display. Secondly, because the image is the two-dimensional projection of the three-dimensional object, the image in two-dimension can't reconstruct all of the stereoscopic information of the object, so it makes image recognition more difficult in the two-dimensional stage. In addition, of course, there are many problems in digital image processing that need to be solved by researchers. The root cause of these problems is that it is often not people who process and analyze images, but machines or computers. This non subjective way of thinking through code makes computers often do not have the ability to judge images through human perception, which is also one of the problems facing the field of digital image processing and artificial intelligence. Through the research of papers in recent years, it is not difficult to find that digital image processing is mainly used in remote sensing technology, medical observation, human feature recognition and intelligent transportation. By researching these relative studies, it is practical to further sort out the basic context of the development of digital image processing.

3. Development of digital image processing

3.1. Digital Image Processing in Remote Sensing Technique

Remote sensing technology is a kind of methods which collects the electromagnetic radiation information of objects on artificial satellites and then determines the environment and resources of earth. Modern remote sensing technology mainly includes the acquisition, transmission, storage, and processing of information, among which the

information processing equipment includes color synthesizers, image readers and digital image processor.

Among them, hyperspectral resolution remote sensing has developed in imaging spectroscopy. Compared with traditional remote sensing, a hyperspectral resolution imaging spectrometer provides a very narrow imaging band for each imaging pixel, and it is approximately continuously distributed in a certain spectral interval, which can increase the amount of spatial information of the ground object spectrum. At present, the radar that can produce high-resolution imaging is mainly synthetic aperture

radar (SAR), which can obtain high-resolution radar images which is similar to optical photography under the meteorological conditions of extremely low visibility. The smaller real antenna aperture is synthesized into a radar with a bigger equivalent antenna aperture with the data processing by using the relative motion between radar and target. Nowadays, the development of SAR mainly focuses on imaging [1] and noise removal [2].

In order to obtain useful information from this information-rich image and restore its physical field attributes, the data of hyperspectral horizontal situation indicator (HSI) and digital surface model (DSM) images usually have lower spatial resolution and more complex coverage types, and the different bands of HSI are highly correlated and redundant, so it is difficult to extend the traditional independent identically distribution (IID) processing model of RGB images to HSI images. Jin et al. proposed the method to process and get the information from the HSI data with hundreds of channels [3]. Using spherical harmonic illumination, the convenient HSI and DSM rendering model which represents the interaction of reflectivity of material, geometric distribution and environmental illumination was first proposed. By introducing local and nonlocal reflectivity prior theory to ensure the local smoothness and global consistency of the restored reflectivity, the authenticity of hyperspectral image restoration will be ensured.

In addition, due to the sensitivity of detection, hyperspectral images often have noise that interferes with the signal. In order to solve these obstacles, Zhuang et al. introduced the RhyDe (R obust hy perspectral De noising) denoiser to achieve an explicit low-order representation, and they retained rare pixels by using a form of collaborative sparsity [4]. The proposed denoiser with good robustness and the effectiveness of detection were proved by using semi real and real data. Through the preliminary processing of the original information, many kinds of characteristic information from the image can be analyzed. The main types of analysis are landform analysis [5], vegetation analysis [6] and cloud analysis [7], which are derived from the wide use of high-resolution digital elevation model (DEM). At the same time, through shape correction and improving color tolerance, these high-resolution images can still retain most of the useful information after reprocessing.

3.2. Digital Image Processing in Medical Imaging Technology

With its integration of numerous new technologies from the fields of computer science, physics, biomedicine, and other areas, medical imaging technology is a crucial tool for medical research and clinical medicine. It has evolved into a rapidly growing field of medical technology over the last 20 years. One of the most active areas of research is the use of computer image processing to aid in medical diagnosis and treatment. This has substantially improved the accuracy of diagnosis and treatment. According to the actual application of clinical medicine, medical image technology can be divided into two categories: structural imaging technology and functional imaging technology. Structural imaging technology is mainly applied to obtain internal structural images of the tissues to be dissected in human body. The application of this technology makes it convenient

for doctors to observe the actual situation of patients. Functional imaging technology takes images as the carrier of information, and reflects the operation of some organs in patients through the changes in images. The use of digital images in medical treatment is mainly reflected in image extraction [8], image enhancement [9], image perception, etc., which aims to provide convenience for doctors in diagnosis and improve the accuracy of diagnosis to a certain extent.

Image segmentation, medical image registration, and medical image fusion are all examples of medical image processing technology that is used in the diagnosis process. In these technologies, Z. et al. proposed a more efficient convolutional neural networks (CNN) model, which is called the dynamic deep learning integration model of multi-level context and uncertainty aware (MCUa) [10]. The MCUa model is composed of multiple multi-level context aware models, which learn the spatial dependence between image blocks in a hierarchical manner. It realizes a new dynamic integration model by taking advantage of the high sensitivity of uncertainty quantification components to multi-level context information. These image processing technologies are mainly completed through algorithms.

Image segmentation technology is a process of segmenting the diseased tissue and then searching. This process requires the machine to complete the search and analysis of the diseased tissue, so that it can be arranged according to the correlation. In order to ensure that this search is also accurate and reliable for the image of moving objects, Q. et al. proposed a new multi-view motion estimation network to accurately evaluate the motion state of cardiac muscle, which integrates 2D common mode rejection (CMR) images obtained on the short axis and long axis planes [11]. In this method, by using the fusion representation of multi view images, a 2D-3D hybrid network is established to generate a dense 3D sports field. In order to ensure the consistency of 3D motion estimation, they introduced the shape regularization module in the training process and used the shape information in multi view images to weakly supervise the 3D motion estimation so as to ensure the best accuracy of the algorithm.

The correct preservation and confidentiality of electronic medical information also gradually entering people's vision. F. et al. proposed a medical image multi watermarking scheme based on quantum random effect optimization algorithm which will be used to ensure the integrity of embedded logo images, and embed text data in unnoticed areas to hide private information [12]. The accuracy of medical image verification can be improved which is benefit to ensure the concealment and authenticity.

3.3. Digital Image Processing in Human Feature Recognition

Human feature recognition technology generally refers to the process of identifying a human’s unique physiological characteristics to determine the password. At present, mainstream recognition technology mainly includes fingerprint recognition and face recognition. For fingerprint recognition, its texture complexity can provide the need for recognition, but in order to make up for the quality defects of the image, it is often necessary to use image enhancement technology to improve its robustness. The use of digital image processing technology can eliminate noise, enhance the contrast of ridge and valley lines, and improve the image quality to achieve better recognition results.

For face recognition, it focuses more on the recognition algorithm, which in turn is face recognition based on algebraic features, face recognition in view of geometric features and face recognition based on connection mechanism. In this process, digital image processing technology is mainly reflected in supplementing image brightness, improving contrast and sharpness, and ensuring the correct recognition rate of the

machine. Nowadays, with the rapid development of various recognition technologies, more new technologies based on feature recognition are emerging. R. et al. introduced a network-based remote visual recognition experiment, which aims to test human proficiency in detecting different kinds of digital image signals based on the principles adopted in psychophysics [13]. By manipulating facial images, especially face exchange, deformation, and modification, the pattern of human recognition image information can be further analyzed, which is helpful to improve the face recognition algorithm. In addition to facial recognition and other modules, skin can also be directly applied to the study of human conditions. S. et al. studied four different kinds of image enhancement techniques to improve the contrast and detail of facial skin images, so as to obtain the corresponding skin care analysis and recommended treatment methods [14]. At the same time, the extensive use of convolution networks also greatly improved the accuracy and speed of human feature recognition, J. et al. proposed an optical flow estimation scheme based on a single image, which uses the dynamic changes of facial muscles to encode
motion information into the representation of global features [15].

3.4. Digital Image Processing in Intelligent Transportation

In the research of intelligent transportation systems, it is a significant way to improve the realization of traffic intelligence to develop traffic information collection equipment that can effectively obtain the operation information on the road, including vehicle flow, vehicle speed, vehicle type classification, traffic density, and other information. In addition, in driverless technology, digital image processing is also particularly important. It is not only to identify vehicles but also needs to be accurate to license plates, driveways, and pedestrians. On the one hand, the recognition of these aspects depends on artificial intelligence. On the other hand, it also needs to be applied to digital image processing, such as edge computing, which is a hot spot of research now. At the same time, in view of the information and

intelligent development trend of traffic management systems, through the exploration of license plate features and location technology, the vehicle license plate character recognition system is also proposed. In addition to basic vehicle recognition and calculation, now digital image processing technology is also used in detection on traffic faults. W. et al. conducted a detailed analysis of vehicle collision through UAV [16]. In this study, the expert supervision method was used to label the pictures, and an image classification algorithm was used to distinguish the risk level of road conditions. In the study of S. [17] et al., for the image recognition used for monitoring, a more specific algorithm is given. The mean shift and projected Kalman filter algorithm were used to enhance the required part from the picture, and strengthen the recognition ability of vehicles in the monitoring traffic, so that the location of accidents can be detected quickly. This high-accuracy recognition algorithm for cars helps to improve the accuracy of computer detection of congestion and other aspects. At the same time, B. [18] et al. used the image processing technology of closed-circuit television cameras to detect traffic conditions from the traffic images on the road, so users can inspect the traffic conditions at a specific time in advance and carry out
traffic planning or intersection traffic signal control.

4. Conclusion

Digital image processing technology has been widely used in our lives, providing great convenience for our lives, production and research. Nowadays, with the participation of artificial intelligence, digital image processing is moving forward into the field of

algorithm research, and the standardization process of related image processing technology will be carried out accordingly. Influenced by the development of artificial intelligence and deep learning, image enhancement algorithms based on deep convolution neural network is gradually proposed. This type of method can meet the needs of digital image processing both in speed and accuracy. This also shows that underwater image processing is moving towards intelligence. At the same time, in order to make the audience more extensive, convenience and miniaturization are also the difficulties that digital image processing algorithms need to overcome. In short, digital image processing technology is used in nearly all aspects of people's lives, creating great social value. With the continuous growth of human needs, digital image processing still has many new aspects to explore, and it will keep on improving and developing in a better direction.

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