IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 09 Issue 07, July 2022
ISSN (Online) 2348 – 7968 | Impact Factor – 6.72
www.ijiset.com

Design of Image Processing System Based on DSP

Gao-fei Wang[1]
[1]School of Computer Science, Qufu Normal University, Rizhao, Shandong, China,276826
([1]wanggf66@126.cm)

Abstract- In the modern society with the rapid development of science and technology, the technology of digital image processing has made rapid development, and it has also been applied in various aspects of people's life, which is more and more closely related to people's life. However, sometimes the quality of digital images cannot meet the needs, which directly affects the use and brings inconvenience to people's work and life. In this case, more useful information can be obtained by a series of processing of digital images. Some techniques of digital image processing are used in these processes. This paper designs a digital image processing system based on Digital Signal Processing (DSP). The system adopts TI's TMS320C55x series digital signal processor, and completes the software design in the CCS integrated development platform. This paper designs and implements the following functions: digital image histogram statistics, digital image edge detection, digital image sharpening, digital image inversion and digital image histogram equalization enhancement. The model is tested and the results are analyzed.

Keywords- *Digital signal processing, Image processing, Gray histogram, Edge detection*

I. INTRODUCTION

Nowadays, with the rapid development of science and technology, people's living standards, quality and needs are getting higher and higher. Digital images are widely used in modern life. In the process of digital image processing, digital signal processing (DSP) technology is an efficient information processing technology. If DSP technology can be applied to digital image processing, it will bring great convenience to the application of digital image [1-3]. The purpose of image processing is to optimize the information useful to users in the image. There are two main purposes: the first one is to improve the visual effect of the image and improve the clarity of image display; the second one is to make images more conducive to computer calculation and processing. With the growth of social needs and the rapid development of electronic products, digital signal processor (DSP) has become the first choice for engineering researchers in the fields of digital image processing, voice processing, radar, logistics and transportation with its high computing speed [4,5]. In foreign countries, Fujitsu in Japan launched intelligent robots in 2005, which can complete relevant visual recognition technology in the process of walking [6]. At present, many units in China have done such researches. For example, the video image processing system based on DSP+FPGA architecture can realize efficient centroid and other tracking algorithms and meet the real-time requirements [7]. The general image processing system based on DSP+FPGA architecture can meet the requirements of power consumption and real-time, and is easy to maintain and upgrade [8,9].

This paper designs a digital image processing system to realize some basic processing of pictures.The design process is divided into two parts: hardware and software. In the hardware part, the hardware selection is completed; In the software part, the specific programs of each function are designed and tested respectively, and then the results are analyzed. In the end, the paper makes a summary and an outlook, and analyzes the shortcomings of the whole model.

II. INTRODUCTION TO RELATED TECHNOLOGY

A. Digital Signal Processing Technology

Digital signal processing (DSP) is closely related to many disciplines. Digital signal processing uses specialized tools to analyze, collect, synthesize, transform, filter, estimate, compress, identify other processing signals through digital methods, so as to obtain valuable information [10]. The development of digital signal processing theory is attributed to the help of many other related disciplines. With their help, digital signal processing is developed. It is closely related to network theory, signal and system, control theory, communication theory, fault diagnosis, etc. [11-15]

DSP is used in two different meanings. In some cases, it can be referred to as Digital Signal Processing, and in other cases, it can also be referred to as Digital Signal Processor. DSP is a kind of hardware device, which is between ASIC and PC in terms of performance and design complexity. Digital signal processing technology is related to theory and calculation, and digital signal processor refers to the chip used to complete these technologies [16].

B. TMS320C55x Series Processor ions

C55x series is a low-power 16-bit fixed-point digital signal processor launched by Texas Instruments for portable consumer electronics products. C55x is a new processor designed based on the advantages and disadvantages of C54X with C54X as the template. It has the advantages of low power consumption and high performance. It is not only compatible with C54X code set, but also makes the multiplier become two. At the same time, the latest chip manufacturing technology is adpted to greatly improve the main frequency of DSP, thereby improving the processing capacity of C55x series processors. Because of these advantages, C55x series processors are widely used in wireless communication [17].

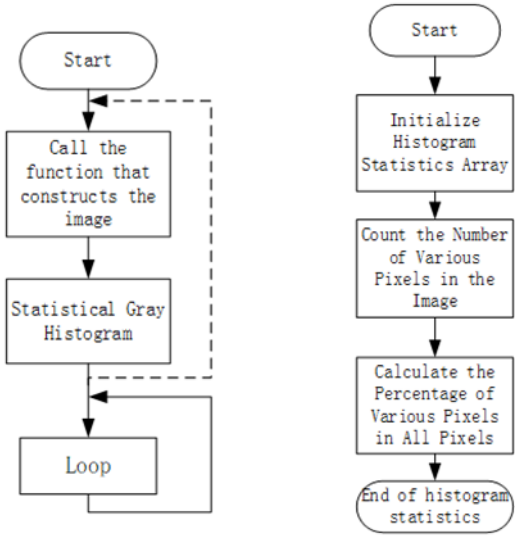

Figure 1. Flow chart of digital image gray histogram

III. PROJECT DESIGN

After a series of analysis of the DSP chip, according to its advantages, it is used as the core processor of image processing to design and implement a variety of image processing functions in the CCS integrated development environment: digital image histogram statistics, digital image edge detection, digital image sharpening, digital image inversion and digital image histogram equalization and enhancement [18,19]. Then the digital pictures are processed by the system, and finally the results are analyzed.

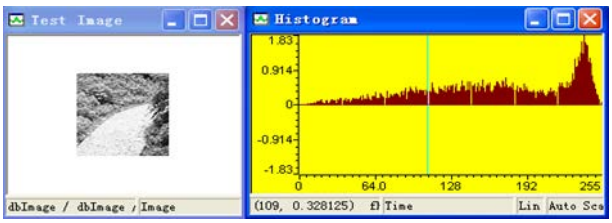

Figure 2. Road image histogram

A. *Hardware Selection*

The implementation of all functions and the operation of the system are completed with the participation of the processor, so it has a high position in the whole framework, and all designs are completed on its basis. Among all processors, there are two kinds of CPUs that can be used for image processing, one is DSP processor, the other is specialized image processing chip. Because DSP processor has the following advantages: (1) rich peripherals (2) special addressing mode (3) programmability (4) powerful data processing capability (5) high integration, DSP processor is selected. Finally, TMS320VC5509 chip with low cost and high quality is chosen from general processor [20].

B. *Software Design*

1) *Digital Image Gray Histogram Statistics:*

Gray histogram is a simple and useful tool in digital image processing. It describes the content of an image with gray level. The histogram of any image contains a lot of information, and even some images can be completely described by their histograms. The gray histogram describes the number of pixels with the gray value in the image. Its abscissa represents the gray level of the pixel, and its ordinate is the frequency of the gray level (the ratio of the number of pixels to the total number of pixels in the image). The flow chart is shown in Fig. 1.

Through the system processing, the histogram of the input original image can be obtained. The horizontal axis of the histogram represents the gray level of pixels, and it ranges from 0 to 255; the vertical axis of the histogram represents the frequency of pixels with different gray levels. The results can be analyzed according to the histogram obtained.

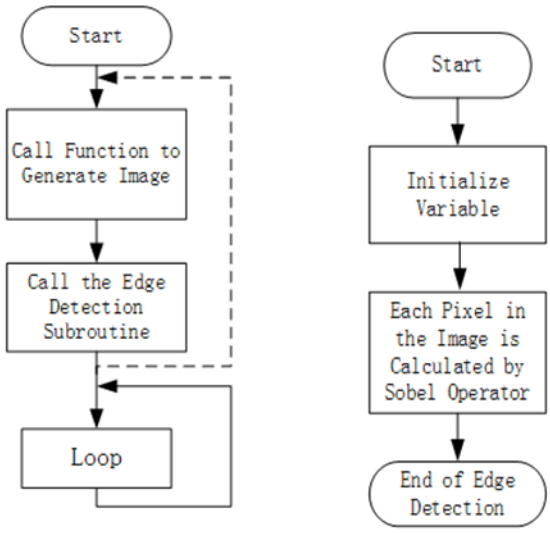

Figure 3. Flow chart of digital image edge detection

As shown in Fig. 2, the input image is shown in the Test Image window and the processed gray level square is shown in the Histogram window. It can be clearly seen from the histogram that there is a very obvious "peak" on the right side of the histogram, and the position of this peak is the part of the region with large gray value, so the region where this peak is located is the gray level of the road part in the original image. As long as the data in this part is captured, the image of the road can be obtained.

Figure 4. Human image edge extraction

2) Digital Image Edge Detection:

Image features can be used to distinguish the key information in the image. Image features can be divided into two kinds, one is called statistical features and the other is called visual features. The statistical features of an image are defined artificially; Visual features refer to the features that people can directly observe through intuition when observing a picture, such as the brightness of the picture or the outline of things in the picture. The edge of the image is the most basic among these features. The edge that people often say actually refers to the set of pixels in the image where the gray level has changed step by step. Usually, the image will have edges, such as between objects and backgrounds, between objects and objects, between primitives and primitives. In the histogram, the edge of the object is represented by the step or discontinuity of gray scale. So the most typical method of edge extraction is to observe the change of gray value in a certain area of the image. Then it detects by using the law of different changes of the nearby first-order or second-order directional derivatives. This method is called edge detection local operator method. There are two kinds of common edges, one is step edge, and the other is roof edge. The flow chart of program is shown in the following Fig. 3. The result of image processing is shown in Fig. 4.

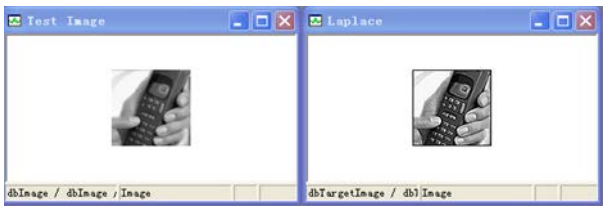

Figure 6. Sharpened image of a mobile phone

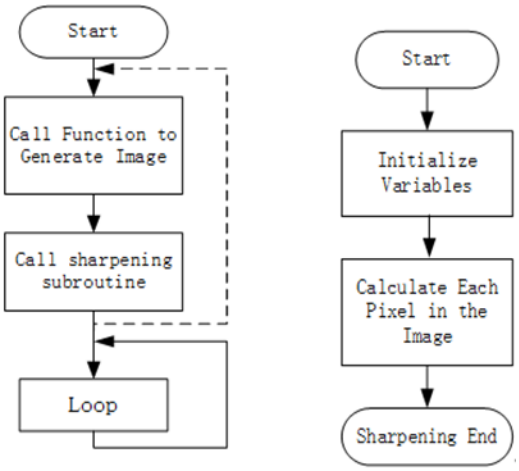

Figure 5. Digital image sharpening flow chart

As shown in Fig. 4, the original image is shown in the Test Image window, and the edge extraction image obtained after processing is shown in the Sobel window. The content in the original image is a human image, and there is a step phenomenon of gray value in the edges of a character, so the edge details of the character is successfully detected in the result image.

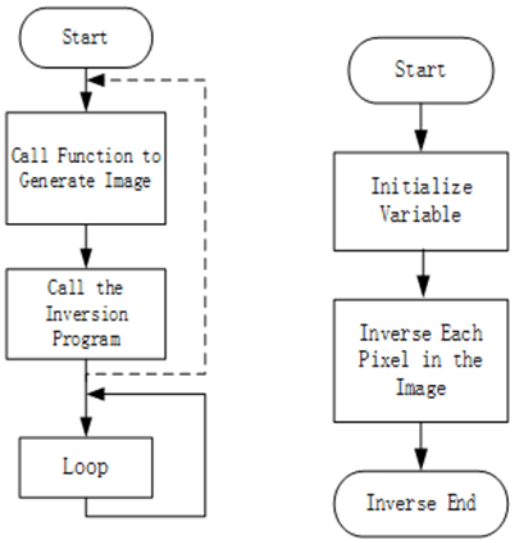

Figure 7. Flow chart of digital image inversion

3) Sharpening of Digital Image:

Sometimes some pictures are not clearly displayed, and the details are very vague, which is not conducive to observation. At this time, it is necessary to sharpen the picture. After sharpening, the details of the image become more prominent and clearer. The blurring of digital image is often caused by the average or integral operation of the image, so we can start from here and do inverse operation on the image to make the image clearer. However, in the process of processing, it should be noted that if you want to sharpen the target image, the target must have a high signal-to-noise ratio, because the signal-to-noise ratio of the image after sharpening will be reduced to a certain extent. If the signal-to-noise ratio is not high, the noise after sharpening will be more than the signal, so generally, the image will be denoised before sharpening. The flow chart of program is shown in Fig. 5. By running the program, the sharpened image of the original image can be obtained, and the processing results are shown in Fig. 6.

The original image is shown in the Test Image window on the left of the above figure. The effect image obtained after processing is shown in the Laplace window. After sharpening, the lines of the original image become clearer, highlighting the lines on the hand. Moreover, the keys of the mobile phone are also more stereoscopic and clearer, and the clarity of the whole image is greatly improved after processing.

4) Inversion of Digital Image

Inversion is a relatively simple process. After inversion, an image will become an effect similar to that of a negative. For example, black-and-white images will be flipped to show the inverse image. The flow chart of program is shown in Fig. 7.

Figure 8. Gray bar inversion image

Digital image inversion processing results are shown in Fig. 8. The original image is shown in the Test Image window, and the results obtained after processing are shown in the Reverse window. The original image is composed of 16 different gray bars. After the inversion processing, it can be observed that the image has changed upside down, the original black part becomes white, and the white part becomes black.

5) Histogram Equalization Enhancement of Digital Image

In digital image processing, gray histogram is a very useful tool. Using the results of gray histogram, the means of histogram equalization can be called histogram equalization. It can enhance the effect of image display. According to the histogram display, it is easy to observe whether the gray value distribution in an image is even, so that we can make the gap between the areas with high proportion of gray value and the areas with small proportion more prominent. To put it bluntly, it is to reduce the gray value range of the small proportion areas in the histogram, and then increase these spare areas to those parts with high proportion respectively according to the proportion. This processing method is mainly aimed at people's visual senses, so that the processed image is more easily observed by people's naked eyes. The results are shown in Fig. 9 and Fig. 10.

The input image is shown in the Test Image window, the processed image is shown in the Enhance window, and on the right side are the corresponding gray histograms of the two images on the left. The original image is composed of continuous gray values, and most of the gray values in the image are concentrated in the critical area of 140. It can be clearly seen that there is only one "peak" in the histogram. After processing, the "peak" is expanded to a larger area, so the final image is richer in detail.

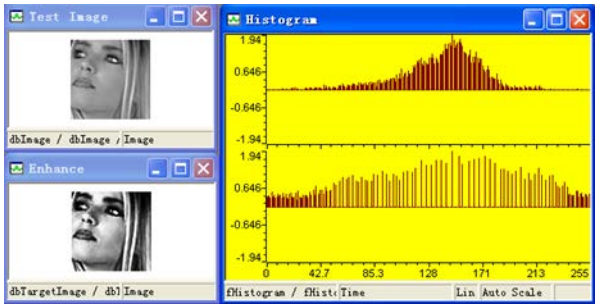

Figure 9. Portrait equalization enhancement effect image

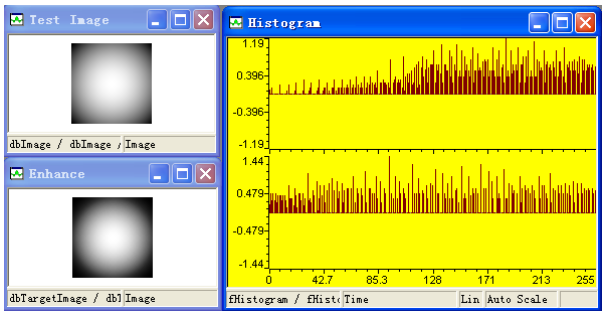

Figure 10. Continuous gray level equalization enhancement image

The input image is shown in the Test Image dialog box, and the processed image is shown in the Enhance dialog box and on the right side are the corresponding gray histogram of the two images on the left. The original image is composed of continuous gray values. Through observation, the proportion of black pixels is smaller, and the white pixels in the image occupy a larger area. Therefore, in the gray histogram, at the left end of the horizontal axis, the closer it is to the zero point, the smaller the statistical value is. On the contrary, the gray values on the right side of the horizontal axis are not only dense, but also generally high in statistics. So in the processed image, the white area is moved down to replace the black part, and finally the change in the edge part of the image becomes more distinct.

IV. CONCLUSION

The design of image processing system based on DSP includes hardware equipment selection, program design and system test. The realization of the system mainly lies in the part of program design, which mainly realizes the functions of image histogram statistics, digital image edge detection, digital image sharpening, digital image inversion and digital image histogram equalization enhancement.

The design and implementation of image processing system based on DSP involves many aspects of theory, knowledge, methods and technology. There must be more or less problems in this system, which need to be found, modified and improved in practical applications. Further research is needed in the following aspects:

- In this design, only the most basic functions of image processing are considered, and there is no in-depth design of richer functions, which doesn't make the system perform well in the face of some complex situations.
- The images used in this design are generally black-and-white, and the pixels are relatively low, which make the pixels of the digital image obtained after processing in the test relatively low, so the effect is not particularly good.
- The application scope of relevant DSP knowledge in the process of system development and design is not wide enough, and there is room for improvement.

REFERENCES

[1] Zhu youxiu.Development of real-time image processing system based on DSP[J].New Technology & New Products of China,2017,(19):34-35.
[2] Qin Tianlun.Analysis of fingerprint recognition technology in digital image processing[J]. Wireless Internet Technology,2022,19(06):96-97.
[3] Wu Yingnan.Discussion on the application of digital image processing technology in the era of integrated media [J]. News culture construction,2022(05):71-73.
[4] Xiang Shuai.Research on sonar image processing technology based on dual core DSP [D].Harbin Engineering University,2017.
[5] Wang Min, Wang Kang, Zhuang Zhihao,et al.Logistics sorting method and system based on digital image processing[J].Information technology and network security, 2021,40(11):83-88.
[6] Luo Kuanhuai. Design and algorithm implementation of image processing basic platform based on DSP [D]. University of Electronic Science and technology, 2017.
[7] Liu Xiaoming,Tian Yan, Xu Zhaohui.Design and implementation of video processing system based on DSP and FPGA[J]. Laser and infrared,2007(12):1328-1330.
[8] Sun Hao, Chen an, Hu Yueming.Design of general image processing platform based on DSP and FPGA [J].Electronic design engineering,2009,17(06):41-43.
[9] Wang Zemin.Design and implementation of FPGA and multi-core DSP image processing system [D].Xi'an University of Electronic Science and technology, 2017
[10] Zhang Hui, Hu Guangshu. Characteristics, development trend and application of DSP[J]. Electronic products world, 2004 (09): 35-37+3.
[11] Yang Qi, Zhang Yani, Zhou Yuqing, et al.A summary of complex network theory and its application in the field of public transport resilience [J]. Chinese journal of highway, 2022, 35 (04): 215-229.
[12] Li wuzao, Guo Shuyi, Ren Sijie.Overview of fuzzy control theory[J].Henan science and technology, 2019 (11): 12-15.
[13] Chen Youguang, Chen Yun, Xie Kunpeng. Fault diagnosis of planetary gearbox based on MEEMD-SDP image features and DRN [J].Electromechanical engineering, 2022,39 (05): 662-667.
[14] Ma Chunbin, Huang Wen, Li Zongze. Research on circuit board fault diagnosis system based on multiple images [J].Computer measurement and control, 2022,30 (03): 15-18.
[15] Zhao Lihua, Xu Li, Liu Yan, Liu Jianzhen, Huang Xiaolong.Transformer mechanical fault diagnosis method based on point symmetric transformation and image matching[J]. Journal of electrotechnics, 2021,36 (17): 3614-3626.
[16] Chen Donghua.Research on low bit rate real-time video transmission technology based on DSP [D].Suzhou University, 2003.
[17] Zhu Ming, Lu Jianfeng, Zhao Jian, et al. Design of real-time digital image processing system based on TMS320C6202 DSP [J]. Optical precision engineering, 2003 (05): 497-501.
[18] Mao lina. Discussion on the application of forced type conversion in C language teaching[J]. Modern computer (Professional Edition), 2009(12):135-136+146.
[19] Xu Zhimin, Wei Haifeng, Lu yanru. Design of infinite impulse response filter (IIR) based on Code Composer Studio [J].Computer and digital engineering,2021,49(04):818-821.
[20] Guo Jingying, Wu Qing, Shang Qingrui. Hardware design of fingerprint identification system based on TMS320VC5509A[J]. Security technology,2007(02):47-50.

Gao-Fei Wang received the B.S. degree in communication engineering from Shandong University of science and technology, China, in 2019; the Master degree candidate in computer science and technology from Qufu Normal University, China. His research interest is bioinformatics.

How to Cite this Article: %Leave it blank for Publications Department to complete%	Direct Link to the online version