

Exploration on practice teaching reform of Photoelectric Image Processing Course under applied transformation

Binfang Cao*, Xiaoqin Li, Changqing Liu, Jianqi Li

College of Physics and Electronics Science, Hunan University of Arts and Sciences, Chang de,
Hunan 415000, China

ABSTRACT

With the further applied transformation of local colleges, teachers are urgently needed to make corresponding changes in the teaching content and methods from different courses. The article discusses practice teaching reform of the Photoelectric Image Processing course in the Optoelectronic Information Science and Engineering major. The Digital Signal Processing (DSP) platform is introduced to the experimental teaching. It will mobilize and inspire students and also enhance their learning motivation and innovation through specific examples. The course via teaching practice process has become the most popular course among students, which will further drive students' enthusiasm and confidence to participate in all kinds of electronic competitions.

Keywords: practice teaching; innovation ability training; applied transformation; photoelectric image processing; DSP technology

1. INTRODUCTION

Recently, many higher educational colleges have opened Photoelectric Image Processing course which contains image collecting and digital image processing. As a new developing subject, photoelectric image processing technology has been widely used in communication, medicine, automatic control, aerospace, military and other fields. It also shows an irreplaceable important position^[1-2]. In order to improve its teaching and training effect, the DSP platform is introduced to the experimental teaching and used to demonstrate image processing effect. Teachers allow students to design their own image processing algorithms and compare image processing effect on the DSP platform, which will guide them to innovate. Therefore, it is of great significance to study on photoelectric image processing practice teaching reform fused DSP technology.

2. PHOTOELECTRIC IMAGE PROCESSING COURSE CHARACTERISTICS AND TEACHING STATUS

Photoelectric image processing is a combination professional course of theory and practice, the curriculum arrangement is divided into two parts: theoretical teaching and experimental teaching. The course has the following characteristics. Firstly, image processing is a highly academic course using matrix analysis, orthogonal transform and two-dimensional integral mathematical

knowledge, to put forward higher requirements on the theoretical basis. The curriculum content is complex and the algorithm is not intuitive. Secondly, there are many contents, mainly including four parts: the basic theory and imaging methods of photoelectric imaging, the basic theory and method of digital image processing, the application of photoelectric image processing and the experiment of image processing methods^[3]. The last, the course is closely related to practical application. It not only requires students to understand and master theoretical knowledge of digital signal processing and related algorithms, but also requires students to have a certain ability of computer programming. All those characteristics above make traditional teaching mode in this course more obvious limited. Therefore, teaching reform is more urgent needed. In particular, the experimental teaching reform needs to make the abstract, boring physical concept more intuitive and vivid in order to inspire students to accept and understand easily. In this way, the classroom teaching quality and effectiveness will be effectively improved.

3. PRACTICE TEACHING REFORM THINKING

In the Photoelectric Image Processing practice teaching, the writer used EL_DM6437 Da Vinci DSP demo platform to realize image processing algorithm program in DSP platform. The results can be observed in real time.

3.1 EL_DM6437 Da vinci video development platform

The DSP demo platform this college used is EL_DM6437 Da Vinci video development board. The EL_DM6437 Da Vinci video development board expands 64Mbytes DDR2SDRAM via a dedicated DDR2 storage controller interface, which brings high throughput, high capacity storage for video applications and the DDR2SDRAM can be extended to the maximum storage 256MByte. 256Mbit NorFlash guarantees a powerful capacity for offline video applications. The board connects with CPU by a video decoder chip. So that CPU can accept external composite video signal input and S signal input. In addition, the signal is automatically detected, which greatly improves video processing flexibility. CPU will also provide video DAC and can change the DDR2 memory data into users' observable signal through a number of operational amplifiers. It is very convenient. Besides, the board also contains a lot of resources, including audio input and output, 10M/100M adaptive Ethernet interface, USB2.0 interface, real-time clock, 4 bit LED instructions and 4 bit DIP switch input, CAN bus and UART interface a series of functions else like this. The most important thing is that all external memory interface signals are connected to the expansion interface, so that the user can design the external sub-board to expand their own function^[3-4].

The DSP experiment demo platform image process is as follows. At first, color CCD image collecting output video signal. After passing through the video decoder, we will get digital signal. Then run the algorithm program in the DSP chip to realize real-time image processing. In this paper, we adopt the TMS320DM6437 DSP chip from TI Company. The image is processed and restored into a video signal through a video encoder and then to observe the processing results through video monitor. Through demonstration and application in practice teaching process,

students will further understand image processing theory and abstract concept. It will also enhance their learning interests.

3.2 Practice teaching based on EL_DM6437 platform

Take the following image edge detection operator as an example. The traditional image edge detection operators include Roberts, Sobel, Prewitt, Canny and Laplasse etc. When teachers speak the process about each kind of edge operator detecting the image edge. Students will first know the principle and importance of image edge detection. Then they will carry out the image edge detection experiment and analyze the effect on DSP experimental platform. Finally, they need to further study on edge detection theory combined with experiment and expand its application in each field.

(1) Analyze Sobel operator image edge extraction principle combined with experiment

Image edge refers to that part where the image intensity changes most obviously. It mainly exists between object and object, object and background, region and region (including different colors). It is also an important basis for image analysis, such as image segmentation, texture feature and shape feature.

The basic idea of edge detection is to use the edge enhancement operator to highlight the local edge of the image, and then define the image edge intensity. And, to extract edge points by setting threshold. Right sobel gray value of each pixel in the image, up, down, left and right neighbors field of weight difference, with the largest neighborhood close. Therefore, the Sobel operator is defined as follows.

$$s_x = \{f(x+1, y-1) + 2f(x+1, y) + f(x+1, y+1)\} - \{f(x-1, y-1) + 2f(x-1, y) + f(x-1, y+1)\} \quad (1)$$

$$s_y = \{f(x-1, y+1) + 2f(x, y+1) + f(x+1, y+1)\} - \{f(x-1, y-1) + 2f(x, y) + f(x+1, y-1)\} \quad (2)$$

Then, using two kernels in Figure 1 as convolutions. One kernel has the biggest influence on usual vertical edge while the other kernel has the biggest influence on horizontal edge. The two convolution maximum is taken as pixel output value and the operation result is an edge image.

Properly take TH as threshold. If $R(i, j) \geq TH$, then it is step edge point. Sobel operator uses pixels up, down, left, right gray weighted algorithm to detect edge according to extremum principle at the edge points.

Figure 1. Sobel edge operator

-1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

(2) Sobel operator image extraction based on Da Vinci platform

This part mainly include the following steps. ① separately connect computer with emulator, EL_DM6437 with emulator. Using one video cable head to connect P3 or P5 socket on the board. The other end connects with AV input of the display and transfers to the AV mode. Using video cable to connect camera output and P9 socket on the board. Pay attention to set camera output standard to PAL. □ Electrify EL_DM6437 and camera, then turn on CCS and connect. Open the project EdgeDistillUseSobel.pjt. This project feature is, to carry Sobel edge extraction on camera captured images and output to the monitor. Download the program “out” file. The camera is aimed at capturing image site. □ Set the first breakpoint at the 423th line of video_test.c. Click Run, wait till the program stops at the breakpoint. At this time, you can see the image from the monitor as shown in figure 2. Continue to click Run. If succeed, the display will show edge extracted image as shown in Figure 3.



Figure 2. Original Image



Figure 3. Sobel operator edge detection results image

(3) Characteristic analysis of Sobel operator image edge detection

Compared with other operators, the Sobel operator has two distinct features. First, due to the introduction of the average factor, it has a smoothing effect on the random noise in the image. Second, since it is the difference between two rows or two columns, the elements on both sides of the edge have been enhanced to make the edges appear thick and bright.

However, the disadvantage is that the edge is coarse, the amount of calculation is increased while the noise resistance is good, and the false edge is detected. So the positioning accuracy is not high. Combined with the above analysis, students are required to be familiar with the DSP system operation process. Take edge detection as an example, students need to know edge detection procedures programming (assembly language or C language), link command file modification, new project creation, project Compile - Link - Load - Run. Finally, students need to analyze the performance of the algorithm by experiment effect. It also requires students to be familiar with other edge detection algorithms, to compare each algorithm by experiments and to form analogical learning habit.

4. CONCLUSIONS

Teachers should give full consideration to the related courses connection when they arrange their teaching plan. Such as "signals and linear systems" and "digital signal processing" are professional basic courses. We are scheduled to open these two courses in the fourth and the fifth semester. Then we will arrange DSP system development and photoelectric image processing courses in the first 8 weeks and the latter 8 weeks of the sixth semester. This can effectively ensure the continuity of the signal processing course group. After finished photoelectric image processing course teaching, teachers will arrange photoelectric image processing course design. In order to make students further known and understood the curriculum knowledge and enhance their enthusiasm and innovation. The preliminary results have been achieved through two terms students teaching trial. The study of the course will help the students to achieve excellent results in the electronic design contest and photoelectric design contest and a series of contests. It will also enhance the enthusiasm and confidence of students to participate in the competition.

5. ACKNOWLEDGEMENTS

This work was supported by Hunan Education Science "12th Five-Year" Plan Project (XJK014QG D009), the Teaching Research and Reform Project of Hunan University of Arts and Science (JGZD 1611), the Teaching Research and Reform Project of Hunan Provincial Education Department (24 7_396(2014)), and the School-enterprise Cooperated Innovation and Entrepreneurship Education Base of Hunan Province Optoelectronic Information Technology (394_2016), China.

REFERENCES

- [1] Gonzalez R C, Woods R E. Digital Image Processing (3rd Edition) [M]. Prentice-Hall, Inc. 2002.
- [2] Zhenming Peng, Yang Yong, Jing Zhang. The exploration of new practical teaching mode of Photoelectric image processing course [J]. Higher education research: chengdu, 2011(1):67-68.
- [3] Romanova G E, Tochilina T V, Bakholdin A V. Competition in optics for students: organization and realization of the practical and theoretical tours [J]. Review of European Studies, 2015, 7(7).
- [4] <http://www.techshine.com/productshow.asp?id=125&mnid=5293>
- [5] Sifang Zhang, Zhengming Li. Study of an image tracking system based on DSP [J]. Optical precision engineering, 2002, 10(6):573-577.