Project-oriented Teaching Model about Specialized Courses in the Information Age

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ABSTRACT

Specialized courses play a significant role in the usage of basic knowledge in the practical application for engineering college students. The engineering data available has sharply increased since the beginning of the information age in the 20th century, providing much more approaches to study and practice. Therefore, how to guide students to make full use of resources for active engineering practice learning has become one of the key problems for specialized courses. This paper took the digital image processing course for opto-electronic information science and technology major as an example, discussed the teaching model of specialized course in the information age, put forward the "engineering resource oriented model", and fostered the ability of engineering students to use the basic knowledge to innovate and deal with specific project objectives. The fusion of engineering examples into practical training and teaching encourages students to practice independent engineering thinking.

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1. INTRODUCTION

Digital image processing is an interdisciplinary course combining mathematics, optics, electronics and so on [1]. Rising with the development of computer science and technology [2], this course has wide and important applications in the industrial, medical, military and other fields.

Digital image processing is one of the specialized courses for information engineering colleges. The main teaching goal is making undergraduates master the basic theory, concepts and methods of digital image processing, and cultivating the capacity of undergraduates to use mathematical analysis and computer program to deal with the actual image processing case [3-6]. As the digital image processing focuses on engineering practice ability, students are expected to learn the theory as the basis, adopt the algorithm as the weapons, and cope with various objectives according to their characteristics. Likewise, multiple algorithms, analysis tools, practical cases, etc. play a vital role in the inspiration of innovative ideas.

Since the twentieth century, the information age witnesses the fast development of information technology and industry, and the geometric growth of network resources [7], especially the image processing resources, video data, algorithms,

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and analysis tools. Similarly, numerous network learning platforms and interactive means grow explosively [8-10]. Under this circumstance, how to teach students to use these network resources effectively and initiatively to solve the practical engineering problems has become an crucial issue in the teaching process.

2. THE NECESSITY FOR TEACHING REFORM

Digital image processing consists of the basic concepts, basic theory and practical engineering problems concerning image. Its high comprehensiveness, flexibility and practicality make it a hard-to-learn course. The main contents of the course include: image basic knowledge, graphics acquisition, image enhancement, image orthogonal transformation, frequency domain processing, image restoration, morphological transformation, image compression and so on.

According to the characteristics of digital image processing, the traditional teaching methods have the following problems and shortcomings:

1) The traditional teaching merely focuses on the mathematical expression of the algorithm, ignoring the relation among the various numerical features of images and their vision feelings by human eye, which result in the difficulty for students to set up the relationship between characteristics of the image and the processing algorithms. As a result, it places obstacles for students to apply them in the actual image processing cases. Besides, the traditional teaching contents fail to combine the forefront research of optoelectronic imaging, computer, data storage and transmission, and other related fields with the course itself, resulting in the divorce of students and engineering industry consequently.

2) The majority of students' assignments are the analysis of image characteristics using numerical methods rather than comprehensive training. Besides, all students have to do the same work due to the limited number of subjects, so it is difficult to eliminate plagiarism. At the same time, due to the lack of diversity of images, it is difficult to achieve the purpose of cultivating students' independent thinking and innovation ability.

3) The experiment is an essential part of the digital image processing teaching. As the main method to cultivate students' engineering ability and skills, it is very significant to the cultivation of undergraduates in engineering universities. However, the current experiments ask for little comprehensiveness and practicalities, using only some classic images as well as limited classic algorithms, which lead in students' lack of the ability to statistically analyze the characteristics of quantitative similar images and construct processing flow with multiple algorithms according to these characteristics in actual engineering cases.

4) The existing curriculum teaching often adopts the one-to-many model. Teachers can solely communicate with their students in the limited class time. No network platform or interactive methods are used, and no real-time communication as well as interactive learning is achieved.

In view of the above problems, this paper put forward the "engineering resource oriented model", aiming to foster the ability of engineering students to use the basic knowledge and network resources to solve specific project objectives innovatively and flexibly. The lead-in of the engineering examples encourages students to carry out independent engineering thinking.

3. TEACHING REFORM

Aiming at the problems existing in the teaching of digital image processing, the following reforms are made to improve the students' autonomous learning and practical innovation ability, based on the information network engineering source.

1) The teaching means informatization

A network teaching platform based on Tianjin University net http://e.tju.edu.cn as well as the MOOC public network system is established, which effectively realize the network-assisted teaching as below.

a) Teaching resources. Some parts in the digital image processing are difficult to understand and need learn repeatedly. Teachers produce teaching video records of these difficult points and upload the records to the network teaching platform. Then students can see these videos at any time using mobile phones and tablets to strengthen their comprehension. Besides, teachers also upload videos about self-learn parts which will not be explained in classroom due to time limitation. So teachers are able to encourage students to learn by themselves.

b) Teaching interaction. Several network tools and methods are used by teachers to communicate with students and answer their questions as well as puzzles. Except for the network teaching platform, QQ and WeChat also participate in the teaching process. Communication groups based on these two tools are established. The assistant teachers are in charge of the communication groups. They interact with students timely each day, providing a variety of extracurricular knowledge, reminding them to prepare and review what will or has been taught on the class, and expanding their knowledge out of class. Additionally, students can also use these network tools to communicate with each other at any time to share their learning experience and puzzles without time and location restrictions.

c) Teaching extension. In the field of digital image processing, new algorithms and technologies are continuously emerging. Many universities and research institutions at home and abroad have set up their own digital image processing database, providing various kinds of pictures, video resources and algorithm source programs free of charge to the public. In recent years, with the development of open classes, universities have set up their own image processing open classes. Most of these well-made classes are taught by distinguished teachers and have their own focus. Using the resources provided freely by various institutions and the purchased databases of Tianjin University library, teachers integrate the web resources and provide the web links of selected open classes and resources on the network teaching platform according to their teaching schedule, helping the students learn deeply and widely.

2) Teaching content engineering

In order to replace obsolete teaching content out of touch with practical engineering application, actual engineering cases are introduced into the teaching process, and the "learn to solve projects, projects promote learning" model is constructed.

At the beginning of the digital image processing course, teachers show a few actual engineering images or videos, and propose a serial of tasks to be completed, such as feature extraction, target recognition, target tracking and so on. Then for each chapter, teachers instruct the basis of specific image processing, use algorithms of this chapter to process the image or video displayed at the beginning of the class, and achieve different image processing effect through adjusting algorithm parameters. Finally, at the end of the semester, teachers use the various image processing algorithms studied in digital image processing to fulfill the project objectives proposed at the beginning of the semester.

In the teaching process based on engineering examples, in order to motivate students' enthusiasm and innovation, the teachers should satisfy the following requirements:

a) 3-4 persons per group. Each group get its target algorithm through lotteries, select a program platform (Matlab, VC, etc.) at will, and complete the algorithm programming (the algorithm parameters can be adjustable) to process a number of different images and achieve specific goals. In the process, students are allowed to use the network to find other people's programs, revising them to fulfill their own goals.

b) 3-4 persons per group. At the end of the semester, each group chooses an engineering example that teachers proposed at first, completes it with algorithms different from what is used by teachers. In this process, students are allowed to use algorithms not taught in the class.

3) Practical information and engineering teaching

In order to further improve the students' ability of using the image processing knowledge to deal with the practical problems of engineering, the extracurricular comprehensive training is added to the practice teaching.

a) Comprehensive Training Example 1: "Image Fusion".

Find two images on the Internet, and select a program platform at will to write programs to fuse the two images (Fig1.(a) and (b)). The formed image (Fig1.(c)) looks different from a distance or closely. The design reports and programs are asked to be submitted in the end.

This training focuses on the understanding of image frequency, the meaning of high frequency and low frequency components, image synthesis, gray transformation, and their usage. At the same time, as the images used is chosen from the network, it can ensure that no students will use the same image, thus avoiding the plagiarism.
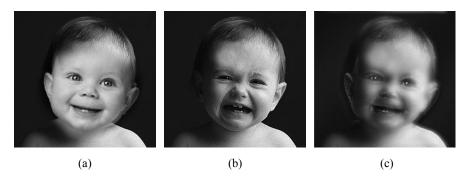

| (a) | (b) | (c) |

Fig.1 Comprehensive Training Example 1. Two original images (a) and (b) are fused to form image (c) which looks different from a distance or closely.

b) Comprehensive Training Example 2: "Number of Students".

At first, the images of students in the classroom (Fig.2(a) and (b)) are required. Students are asked to process these images with self-made programs to count the number of students and recognize the student himself/herself through his/her identification photo match. The program should be able to run step-by-step and the results of each step should be presented. The design reports and programs are asked to be submitted in the end.

This training focuses on the capacity of using color image model, image segmentation, and morphological transformation comprehensively.

(a)   (b)

Fig.2 Comprehensive Training Example 2. Count students number through students' images in the classroom (a) and (b). Recognize himself/herself through matching with the identification photo.

4. CONCLUSION AND DISCUSSION

The teaching reform in digital image processing is aimed to improve the students' ability to use network resources to solve actual engineering problems, including resource search, resource integration, engineering problem analysis and comprehensive application of various image processing algorithms.

1) The improvement of engineering capacity

In the engineering resources oriented teaching reform, students, under the guidance of teachers, experience the whole process of project development, from the "targets analysis" to "tasks decomposition", from "technical design" to "algorithms selection and integration", from the " algorithms preparation" to "program debugging run", and the final completion of the project development. In this process, digital image processing algorithms are no longer boring mathematical symbols, but actual image changes which are related with image character and engineering objectives. Knowledge is transferred into vivid visual image, capturing students' attention, inspiring their enthusiasm, and improving their engineering case solving capacity.

2) The enhancement of resources application ability

The introduction of network resources in digital image processing widens the students' vision, ensures the curriculum content closely follow the frontier research, and breaks the traditional teaching barriers that is concluded as "students learn only what teachers tell them". As the result, the students' ability to think independently, explore initiatively and solve problem creatively are cultivated.

In the information age, abundant open-for-free network resources provide potential ideas for various types of problems. For engineering colleges, whether students can effectively use these resources to solve practical engineering problems has become an important sign of success. The engineering and information teaching reform of digital image processing is an exploration. Its methods, experiences and lessons are all references for the reform of other engineering disciplines.

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