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# Reform and Practice of Multi－level Experimental Teaching of "Digital Image Processing"

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***Abstract:*** As an important content of the teaching work of "Digital Image Processing", traditional experimental teaching methods have certain deficiencies. Based on the analysis of the traditional experimental teaching methods of the course, this paper proposes a multi－level experimental teaching reform plan with the basic layer, comprehensive layer, open layer and improved layer as the layered model, and implemented it in teaching practice, and the teaching effect is good.

***Keywords:*** Digital Image Processing; Hierarchical Model; Practical Teaching

## 1. Introduction

Digital image processing is a fringe subject that integrates optics, microelectronics, and computer applications and applies theoretical knowledge of these subjects to practice. With the rapid development of communication technology, digital image processing has been widely used in digital communication, pattern recognition, and biomedicine. As an important professional course for electronics majors, digital image processing courses have rich teaching content, abstract knowledge points are difficult to understand, theoretical derivation is complex and cumbersome, and the scope of application is wide and practical. In the traditional teaching model, students have a good grasp of theoretical knowledge but poor practical skills. Therefore, it is very important to reform the experimental teaching of the course and to add intuitive and practical experimental links in the teaching process. Based on the analysis of the existing problems in the traditional experiment of the digital image processing course, this paper proposes a multi－level experimental teaching reform. The reform plan is implemented in our college's 18th－level electronic information engineering students, and the implementation effect is analyzed and summarized.

## 2. Curriculum status analysis

### 2.1 The status and role of experimental teaching

As the main component of the teaching activities of science and engineering colleges, experimental teaching plays a pivotal role in students' hands－on practice, teamwork, and cultivation of innovation and entrepreneurship. First of all, in experimental teaching, after the teacher analyzes and verifies the main teaching content in the textbook, students can further better understand the knowledge points and basic concepts and principles; In addition, through specific grouping or individual experimental operations, students can be improved. The ability to solve practical problems. Therefore, experimental teaching is a bridge connecting students' knowledge learning to knowledge mastering, and a means for students to sublimate theoretical knowledge to specific application practice. It occupies an important position in course teaching.

### 2.2 Problems in existing experimental teaching

According to the arrangement of the professional training plan, the "Digital Image Processing" course

generally starts in the 7th semester, and this time is the time for students to find a job interview and an important review time for students' postgraduate entrance examinations. Therefore, in view of the abstractness, practicality and semester of the courses, the existing experimental teaching has the following problems:

There are differences in students' experimental hands—on ability. Some students focus on theoretical knowledge learning and ignore engineering practice. For them, it is difficult to understand the practical "Digital Image Processing", and they usually don't know where to start.

The time for students to preview and prepare for the experiment is different. Because a small number of students are not worried about postgraduate entrance examinations and job hunting, they have sufficient time to preview or complete part of the experiment privately; For most students who want to review and interview for postgraduate entrance examinations and interviews. There is not enough time, so the experiment process is very different.

Traditional experimental teaching methods cannot be adapted. In traditional experimental teaching, the instructor usually fixes the course experiments to a number of constants in accordance with the requirements of the course syllabus. Students with different academic performances do the same experiment together, which is similar to the actual student situation.

The experiment report is similar and serious. Due to the semester of the course, some of them are overwhelmed. Just to complete the credit requirements, the experiment data is plagiarized seriously, and the ability of students is lost.

## 3. Hierarchical model of experimental teaching

In order to achieve the purpose of improving students' engineering practice and innovation ability, according to the characteristics of the course itself, and taking full account of individual particularities and differences, a hierarchical structure of experimental teaching system is built, as shown in Figure 1.

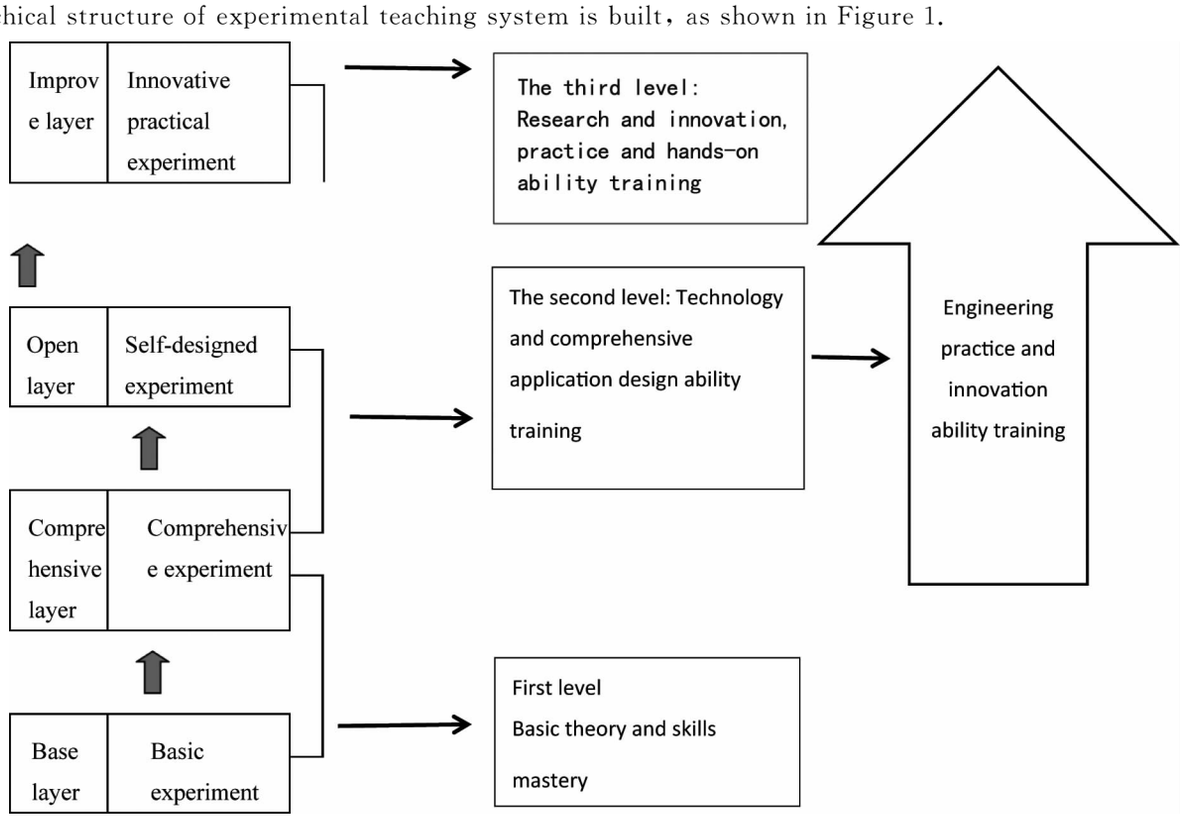


**Figure 1.** A hierarchical experimental teaching system for digital image processing courses

The basic layer focuses on the assessment of basic concepts and principles. The comprehensive layer focuses on the typical applications of algorithms in the course. The open layer and the improved layer open up the laboratory. Students can operate on their own according to their hobbies and focus on cultivating students' application and innovation abilities. It can be seen that the system meets the experimental needs of students of

different levels, teaching students in accordance with their aptitude, students can choose experimental content according to their own level, and have strong autonomy.

## 4. The specific implementation of the layered model

**Table 1.** Digital image processing simulation experiment design based on layering

| No. | Experimental nature | Experiment type | Experiment purpose | Experiment content |
|---|---|---|---|---|
| 1 | Must do | Base | Familiar with and master the use of Matlab, read, save, display and other commands | Program to realize image reading, saving and display |
| 2 | Must do | Base | Understand and master the gray scale conversion and be able to use histogram to correct the image | Programming to realize gray conversion, histogram display and correction |
| 3 | Must do | Base | Understand and master commonly used image enhancement techniques | Smooth the noisy image and use the sharpening template to sharpen the image |
| 4 | Must do | Base | Familiar with and master the principles and properties of image transformation, and realize image Fourier transformation | Use fft2 to perform two－dimensional Fourier transform and convolution on the image to realize the movement of the center point of the image spectrum |
| 5 | Must do | comprehensive | Familiar with and master common image coding methods | Image preprocessing, Huffman, Shannon and run length coding |
| 6 | Must do | comprehensive | Research on the detection method of hair noise in dermoscopic melanomaimages, and repair the information of hair covered parts | Dermoscopic image hair noise removal |
| 7 | Selected | comprehensive | For a given remote sensing image, use the registration principle to search for the position of the reference image on the reference image and mark it | Remote sensing image registration |
| 8 | Selected | Independent design | Analyze cell image features, perform program design and simulation to complete cell extraction, segmentation and measurement | Cell image segmentation and measurement |
| 9 | Selected | Innovation | Independently consult related literature and design image recognition system | Fracture image recognition system based on multifractal and neural network |

### 4.1 Implementation content

During the teaching process of "Digital Image Processing" in 2020－2021, the simulation experiment system shown in Table 1 was established based on the hierarchical experimental teaching system of Figure 1 for the 18－level electronic information engineering students of Xuchang University. The entire experimental system covers the knowledge points required in the digital image processing experimental syllabus. It has a clear hierarchy. Students of different levels can choose according to their personal abilities and interests. Generally speaking, the experiment focuses on the basics and highlights the importance of practice. It has strong manipulability.

### 4.2 Implementation method

In order to achieve the teaching effect, the theory class and the experimental class are held by the same teacher, and the method of centralized and decentralized guidance in class is adopted to realize the synchronization of theory and experimental content. The mandatory experiments in Table 1 are scheduled for 2 hours each time and completed 6 times; For the optional experiments, students will complete them according to their own

abilities and interests, the opening hours of the laboratory and their personal time and their spare time.

### 4.3 Implementation effect

Through the use of the above teaching methods, the experimental teaching of the "Digital Image Processing" course in 2020—2021 has achieved certain results. It is mainly reflected in the following: After the experiment content is divided into different levels, the demands of most students have been realized, the scope of the required experiments has been broadened, and the theoretical verification and application have been expanded; Secondly, the difficulty of the required experiments has been adjusted to some extent. More than 85% of the students were able to complete it independently within the specified time, and the plagiarism of conclusions and reports was effectively curbed. In addition, the level of experimental teaching content is more focused on engineering practice. Therefore, for selective experiments, students are very enthusiastic and motivated to participate, and they have a solid grasp of knowledge points. Classroom effect feedback and evaluation are better than before.

## 5. Conclusion

After carrying out a hierarchical experimental teaching reform in "Digital Image Processing" for 18—level electronic information engineering students, the teaching effect has been significantly improved, the completion rate has increased from 75% to 85%, and the excellent rate has also increased from 3% to 8 %. At the same time, students generally have a good evaluation of the hierarchical experimental teaching model. The knowledge acquired through specific practical projects is easy to understand on the one hand and is also related to other disciplines, which promotes the broadening of students' professional knowledge and also contributes to the promotion of practical teaching in our college. Transitional development provides direction.

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