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Exploration on the Teaching Model of Information Optics for Optoelectronic Engineering Students

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Abstract: Information Optics is a core course for students majoring in optoelectronic information science and engineering, covering fundamental concepts such as Fourier transforms, coherent imaging, spatial filtering, and holography. Based on the author's own teaching practice, along with a meticulous study of the teaching content and curriculum system, and with a clear positioning of the course goals, this paper explores how to implement an efficient and effective teaching model for Information Optics for undergraduate students. To enable students to better understand the abstract concepts of Fourier optics and optical information processing, the teaching significance, teaching content, teaching methods, and student practice forms are discussed, thereby expanding students' thinking space in optical system design, enhancing their learning effect and interest, meeting the requirements of personalized teaching, and strengthening students' comprehensive application capabilities.

1. Introduction

With the rapid development of optoelectronic information technology, the demand for high-quality talents in fields such as computational imaging, three-dimensional display, and optical sensing has been increasing. To cultivate and foster a large number of high-quality technical application-oriented talents with strong innovation ability and adaptability to economic and social development needs, it is essential for schools to train talents based on the requirements of society, adjust the structure of personnel training, improve the quality of personnel training, and enhance the employability of graduates. Information optics technology is an especially significant part of modern optical engineering and plays a crucial role in the development of advanced imaging systems, holographic displays, and optical communication devices [1-2]. Information Optics courses not only focus on the fundamental theories but also emphasize students' practical skills and their ability to connect theoretical knowledge with engineering applications.

Through the study of Information Optics, students can not only understand the principles of Fourier optics and optical information processing but also establish system-level thinking, master operational and practical skills in optical system design and simulation, and lay a solid foundation for subsequent professional courses such as Optical Design, Computational Imaging, and Optoelectronic Detection.

2. Information Optics Teaching and Learning Content

Information optics is a discipline that applies the theories and methods of information science to optical systems, studying the generation, transmission, processing, and reconstruction of optical information. It is considered as an extension of Fourier optics and serves as the theoretical foundation for modern optical engineering. The information optics course possesses the characteristics of strong mathematical foundations, abstract physical concepts, and close integration with engineering applications. It effectively bridges the gap between fundamental optics and advanced photonic technologies, simultaneously helping students develop skills in both theoretical analysis and numerical simulation.

According to the course content, this course is divided into three modules, namely Fourier optics fundamentals, optical information processing, and advanced applications of information optics. Among them, the Fourier optics fundamentals module mainly consists of four parts: the mathematical basis of Fourier transforms, the Fourier transform properties of lenses, the angular spectrum theory of diffraction, and the analysis of coherent and incoherent imaging systems. This module establishes the theoretical foundation for the entire course. The optical information processing module mainly includes three parts: optical spatial filtering, optical correlation and convolution, and optical holography. In this module, students learn how to manipulate optical information in the frequency domain and understand the principles of holographic recording and reconstruction. The advanced applications module mainly comprises five parts: computational imaging, three-dimensional display technologies, optical metrology, adaptive optics, and photonic signal processing. This module introduces students to cutting-edge research directions and industrial applications, forming a complete knowledge system [3-4].

Computer program design and simulation are indispensable components in the practical teaching for undergraduate students of optoelectronic engineering. The aim is to assist students in acquiring basic skills in optical simulation through programming and debugging, foster the ability to integrate theory with practice, enhance the ability to analyze and solve problems, lay a foundation for the subsequent study of advanced optical courses, and strengthen the ability of independent thinking and teamwork. Information optics is a highly practical teaching course, with theory serving as the basis of practice. The nature of this course necessitates the combination of classroom teaching and practical teaching in the teaching process to cultivate students' comprehensive application ability of analyzing, designing, coding, and testing optical systems. However, this leads to some students being negative and fearing difficulties in the learning process, lacking learning initiative, and resulting in poor teaching effects for teachers. It also affects the study of subsequent professional courses.

Firstly, for the teaching content design of Information Optics: Based on the learning objectives and difficulty levels, develop a clear syllabus and course content, and integrate with practical computer simulation courses to provide a comprehensive learning experience. In practical teaching, teachers typically adopt the teaching method that combines theory with simulation to deepen students' understanding of knowledge points and provide timely feedback when students have questions, thereby increasing the interaction between students and teachers. Secondly, it is necessary to assess students' learning outcomes by using online tests, simulation assignments, project practice, and other means to evaluate learning results and adjust teaching strategies in a timely manner. Thirdly, it is necessary to establish a student support and feedback mechanism: set up a student support system, provide channels for learning guidance and doubt-solving, collect feedback from students regularly, and constantly optimize teaching methods.

3. The Challenges and Strategies of Practical Methods for Information Optics

We need to cultivate students capable of addressing practical problems. Therefore, we should not only enhance students' learning ability but also improve their comprehensive ability to analyze and solve problems. We should take students as the center and application as the orientation to better promote the combination of theory and practice.

The traditional experimental teaching mode has the following three disadvantages: (1) Offline classroom teaching has limitations in time and space, which are mainly reflected in the insufficiency of experimental class hours, restricting the development of students' ability to solve practical problems by applying theoretical knowledge. (2) Confirmatory experiments are relatively numerous, while comprehensive design, innovative research, and open experiments are scarce, thus failing to meet the differentiated needs of students at different levels and reducing the interest of students in learning optical theory. (3) The single process evaluation method and the lack of an effective process management mechanism are not conducive to the collection, sorting, and analysis of students' learning data, making it impossible to comprehensively and timely grasp students' learning situation [5-6].

Information optics is a course with strong practicality in teaching. Through practical teaching, students' innovative ability can be cultivated, their learning interest can be stimulated, and the class will no longer be dull and boring. The number of student absences will decrease, and the interaction between students and teachers will increase. In teaching practice, emphasis is placed on explaining the operation points where students are prone to make mistakes. For example: (1) The Fourier transform properties of lenses; we need to explain the difference between the Fourier transform in mathematics and the physical Fourier transform performed by a lens. (2) The concept of spatial frequency and its physical meaning. (3) The relationship between spatial filtering and image processing. (4) The principles of holography and computational hologram generation.

In the process of optical system development, simulation and numerical computation are inevitable parts of the design workflow. Simulation is a process of automatically modeling and predicting the behavior of optical systems when they encounter different input conditions. The simulation methods in the information optics course are to compute the diffraction patterns at runtime and call the appropriate algorithms to visualize the results. The types of simulation can be classified into the following categories: (1) Simulation of Fraunhofer diffraction patterns. When students encounter aperture functions such as circular apertures, rectangular apertures, or double slits, the simulation tools will compute the corresponding Fraunhofer diffraction patterns and display the intensity distributions. (2) Simulation of optical spatial filtering. When students design filter masks such as low-pass, high-pass, or band-pass filters, the simulation platform will compute the Fourier transform of the input image, apply the filter in the frequency domain, and reconstruct the filtered output image. (3) Simulation of computational holography. When students input three-dimensional models or objects, the simulation platform will compute the computer-generated hologram using the Fourier transform or Fresnel diffraction algorithm and simulate the reconstruction process.

Through multiple teachings and example guidance, the traditional model of "teachers talk and students listen" has been changed, and the teaching method of demonstration, explanation, and practice has been adopted, creating opportunities for students to actively participate and independently cooperate, and transforming the teaching form of cramming into a discussion-type research type. According to the differences in students' practical ability and problem-solving ability, students are encouraged to complete more challenging optional projects on the basis of completing the required projects. The student-oriented teaching concept is conducive to stimulating students' interest in learning and mobilizing teachers' enthusiasm in teaching, thereby improving the quality of teaching and talent training.

According to the requirements of the course content, the assessment method of this course is to combine the usual scores with the simulation practice scores, the practical operation assessment with the theoretical assessment, and the basic skills and comprehensive ability evaluation. During the simulation practice, the instructor is required to evaluate and comment on the operation skills and design ability of the students and comment on the problems that students are prone to occur.

4. Conclusions

Information optics aims to cultivate students as engineers to consider and analyze problems, enhance their problem-solving skills and practical ability literacy. Based on the learning characteristics of students during the learning process, the teaching content and resources of the course are further optimized. The course teaching emphasizes new methods, new models, new means, and new thinking. It combines information optics application examples and explains knowledge and technology closely related to optical engineering productization in a targeted manner, which is easily accepted and understood by students, thereby generating learning motivation and vitality.

Through simulation practice, students can connect theoretical knowledge with practical application, deeply understand the application of theoretical knowledge, correct the errors in their simulation programs, and witness the test and verification of the optical systems they designed. This is a highly fulfilling experience, stimulating students' enthusiasm for learning, improving their interest in optics learning, and cultivating students' basic quality of engineering practice ability. It lays a solid foundation for future study and optical system design work. In the subsequent teaching, we will focus on improving the quality of simulation practice and continue to explore practical course teaching forms suitable for the training needs of applied innovative talents and the characteristics of students, so as to meet the personalized learning needs of students and make the practical courses more perfect.

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