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Teaching Reform of Machine Vision in Higher Education Under the Background of Internet Plus and New Engineering

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Abstract. Nowadays, the Internet is becoming more and more widespread in life, production and learning. The use of Internet technology in colleges can help stimulate students' interest in learning, optimize the cultivation mode and improve teaching efficiency. With the promotion of New Engineering teaching mode in China, the practical ability of students is improved. At present, for students in the major of mechanical and electronic engineering, it has become one of the core competencies in employment and entrepreneurship to learn and master machine vision technology. In this paper, under the background of Internet plus and New Engineering, a new teaching mode of machine vision curriculum is proposed by the combination of curriculum theory and practice. Some exploration of teaching reform is introduced from four aspects, namely, ideological and political education, teaching content, teaching method, and the teaching evaluation method. Through the above reform measures, it can improve students' ideological and political quality, stimulate students' interest in learning, guide students to establish a complete knowledge system, and improve students' practical ability and comprehensive innovation ability.

Keywords: teaching reform; machine vision; Internet plus; New Engineering.

1. Introduction

In recent years, with the rapid development of information technology, Internet plus emerges as the times require [1]. The use of Internet technology and Internet thinking can realize the deep integration of modern information technology and education. It will help stimulate students' interest in learning, optimize the training mode, improve teaching efficiency, achieve the purpose of innovative education, and improve the overall level of education informatization [2]. To cope with the new opportunities and challenges brought about by the new round of technological and industrial transformation, New Engineering concept was proposed in 2017 [3]. It aims to cultivate a large number of outstanding engineering who will lead the future development of technology and industry, and to cultivate their innovative spirit and ability to integrate multiple disciplines.

As artificial intelligence, big data, and intelligent manufacturing develop, machine vision technology is more and more wildly used [4], such as in optical character recognition (OCR) recognition, workpiece positioning recognition, size measurement, surface defect detection, robot vision guidance, workpiece random grabbing and other scenes. Learning and mastering machine vision technology has become one of the core competencies of employment and entrepreneurship for undergraduates majoring in mechanical and electronic engineering. Therefore, opening the curriculum of Machine Vision is beneficial to improve the comprehensive ability of students majoring in mechanical and electronic engineering.

At present, the curriculum of Machine Vision has several difficulties. First of all, it has a wide range of contents, including the hardware knowledge of image acquisition such as cameras, lenses, and light, as well as the image processing algorithms with complex concepts and numerous knowledge, such as image enhancement, image segmentation, morphological operation, geometric transformation, feature extraction, etc. Secondly, the multi-disciplinary intersection involving multiple disciplines, such as optical imaging, image processing, automatic control, computer software and hardware, and pattern recognition, makes its expression abstract, resulting in students' learning difficulties. Finally, the curriculum is highly practical. It is closely combined with engineering applications, and its knowledge system is built from the application fields of various

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majors. Students can only apply it after they have a certain comprehensive ability in engineering projects.

Many researchers put forward different curriculum reform explorations and practices of Machine Vision, to deal with the above problems. Some scholars focus on school-enterprise cooperation, establish a machine vision experiment platform, and guide students to participate in school-enterprise cooperation projects [5]. Some scholars focus on analyzing the characteristics of mechanical engineering majors and put forward the application requirements, curriculum planning, and practice teaching system of machine vision technology for new engineering. The experiments of practical teaching include machine vision basic algorithm, the UAV forest fire monitoring and PCB Fault detection experiment, etc. [6]. Some scholars focus on image processing and computer vision algorithms, and use guided question-and-answer teaching and flipped classrooms to strengthen the interaction between teachers and students [7]. Some scholars have established a teaching resource library to make personalized choices of experimental projects by analyzing the data difference in students' learning process, to achieve accurate teaching [8]. These reforms have achieved good teaching results and provided ideas for the teaching reform of the machine vision curriculum for application-oriented undergraduate students.

This paper starts from two aspects: the self-development of machine vision technology and the change in teaching audience. Under the background of Internet plus and New Engineering, the ideological and political teaching mode of Machine Vision curriculum has been increased, the learning of machine vision content has been integrated and enriched, the "dual main classroom" of machine vision has been constructed, and the evaluation system of Machine Vision curriculum has been reformed. Finally, through the above reform measures, students' ideological and political quality has been improved, students' interest in learning has been stimulated, students' complete knowledge system has been guided to establish, and student's ability to solve practical engineering problems has been cultivated. It contributes to the cultivation of mechanical and electronic engineering talents.

2. Analysis of Existing Problems

As the students majoring in mechanical and electronic engineering are non-computer majors, there is a large gap in their knowledge level and application ability. Moreover, the content of the Machine Vision curriculum is extensive and comprehensive, and it needs to pay attention to the cultivation of practical ability, which further brings difficulties to teaching. From the two aspects of the development of machine vision technology and the change of teaching audience, the following teaching problems still need to be faced and solved in this curriculum are summarized.

1) The traditional curriculum lacks curriculum ideology and politics, and cannot expand the breadth, width, and depth of the curriculum to reflect its teaching value and cultural value.

2) The conflict between the knowledge system of machine vision and the rapid learning requirements of mechanical college students.

3) The contradiction between the boring theoretical teaching and the practical application needs of machine vision technology.

4) The traditional teaching material frame system cannot meet the needs of machine vision technology teaching.

Therefore, to enhance their sense of social responsibility, how to enhance students' professional identity and improve their ideological and political quality; How to make students know the latest trends of discipline development in time and help students broaden their knowledge; How to stimulate students' interest in learning and cultivate high-quality talents; How to teach students basic theory in limited class hours, and also focus on training their engineering practice ability. These are the keys to the teaching reform of the machine vision curriculum. Based on this, it is necessary to use Internet technology and the new engineering model to carry out comprehensive

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teaching reform exploration of curriculum thinking, teaching content, teaching methods, and assessment and evaluation methods.

3. Feasibility analysis of reform

3.1 The clear target of reforming the curriculum

The richness of network resources extends the teaching content in time and space, but the fragmentation of knowledge and time also affects the learners' knowledge system and learning concentration. In the whole curriculum reform, through reconstructing and integrating the teaching contents, highlighting the characteristics of mechanical and electronic engineering majors, using various emerging technologies under the condition of Internet plus, establishing the online teaching platform of the curriculum, and running the concept of New Engineering through it. It combines pre-curriculum, in-curriculum, and post-curriculum, as well as online and offline, and builds a process-oriented assessment and evaluation system to meet students' personalized learning needs.

3.2 Wide range of practical applications

The introduction of Internet plus into Machine Vision teaching can effectively improve the efficiency of classroom teaching, expand students' knowledge, and lay a solid foundation for students to contact machine vision technology after employment and further study. By introducing New Engineering into machine vision teaching, machine vision technology can be applied to assembly positioning, defect detection, feature recognition, character reading, dimensional measurement and code tracing, etc. Therefore, training in machine vision technology has a wide application background and practical value for mechanical and electronic students.

4. Implementation plan

4.1 Using Internet plus and New Engineering to increase the teaching mode of ideological and political education

In the reform, ideological and political education is integrated into the teaching process. It organically combines knowledge transfer with value leadership, deeply explores and refines the ideological values and spiritual connotations embedded in the professional knowledge system, and realizes the educational goal of establishing moral education [9]. In the teaching, according to the knowledge and skill points of each teaching unit, firstly, the corresponding teaching cases are selected. Secondly, the ideological and political elements contained in the curriculum are explored. Thirdly, the ideological and political elements are naturally and skillfully integrated into the teaching process of professional knowledge. Finally, the teaching of knowledge and value leadership are given equal importance.

For example, Songchun Zhu, the winner of the 2020 Marr Prize in Computer Vision, returned to China to join Peking University, telling every student that a strong country in science and technology must rely on scientific and technological innovation and industry to serve the country. It means that a strong country requires not only the efforts of a group of outstanding scientists but also the efforts of every student. For example, using the Internet plus platform, video clips from documentaries such as "Great Weapons of State" and other related curriculum content are uploaded. Through the videos, students can learn to focus on China's major projects from different perspectives and develop a sense of national pride and patriotism. For example, during the course, the derivation of the board for the algorithm formula and the citation of the classical literature in the curriculum is introduced, so that students can experience the academic style of rigorousness, honesty, and trustworthiness. For example, according to the concept of New Engineering, students are instructed how to install the software related to the curriculum, so that they can be more quickly integrated into the curriculum and appreciate the good intentions of the teachers.

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4.2 Taking advantage of the change of learning space under Internet plus and New Engineering to integrate and enrich learning contents

The content taught in the Machine Vision curriculum includes, but is not limited to, an introduction to machine vision, machine vision hardware technology, machine vision software platforms, image processing technology, as well as dimensional measurement technology, defect detection technology, and pattern recognition technology. Through the curriculum, not only the basic concepts, fundamental theories, and methods of machine vision need to be mastered, but also the common pre-processing algorithms of machine vision need to be mastered. Case studies and programming are introduced to enhance the application of machine vision, and the ability to apply relevant theories and methods to solve practical problems is initially required by students.

To link theory with practice, using the Internet plus platform, the construction of a curriculum case library can be built. By introducing the concept of New Engineering, practical engineering problems can be integrated into the built curriculum case library. The construction of the curriculum case library will cover a rich variety of project cases for automotive, electronics, transportation, chemical industry, agriculture, medical and other fields. The case library includes several topics, including robot random vision positioning gripping loading and unloading, online vision inspection of machine tool processing parts, visual measurement of tool wear, visual measurement of straightness and size of stamping parts, license plate recognition, weld seam tracking, vision positioning laser marking, weed recognition in farmland, welding defect recognition, precision sheet, strip surface defect detection, and image diagnosis of vascular tumor. Each case is illustrated and edited with short videos to motivate students to learn. The coverage of cases can meet the teaching needs and mobilize students' learning enthusiasm. In addition, it can cultivate students' critical thinking and innovative practice ability and improve their ability to solve engineering problems.

4.3 Using Internet plus and New Engineering to build a "double master classroom"

Traditional machine vision teaching is teacher-centered, with very limited interaction between teachers and students. Due to the lack of collaboration inside and outside the classroom, it cannot meet the individual learning needs of students. To take good advantages of the Internet plus mindset and emerging information technologies as well as the New Engineering concept, a "double master classroom" can be built. In "double master classroom", teaching skills are improved by dynamic learning data analysis and the intelligent information, such as teaching decision data, timely evaluation feedback, three-dimensional communication and interaction, and intelligent resource delivery. Therefore, the teacher's leading role can be played, as well as the students' main position in the learning process can be highlighted.

The curriculum teaching platform is built by teachers and can use a combination of online and offline teaching. Through various information technology tools, rich teaching resources are presented. An organically linked system is formed before, during, and after class. Students are guided to explore actively, and the atmosphere of teacher-student communication and student-student communication is created.

Before the lecture, the teacher can upload corresponding learning resources to the teaching platform, issue learning task sheets, and assign pre-study tasks. Students then use their smartphones or computers to receive and view the learning tasks. Students can summarize at least one question in the discussion forum after watching videos and micro-lessons. Next, the teacher can summarize the questions raised by students and adjust the teaching design according to the concentration of the questions.

In the middle of the lecture, the process of "introduction to the topic - task learning - test feedback - case implementation - task summary" is followed in order. (1) The teacher can introduce the task of the lesson through a typical application case of Machine Vision. Taking pattern recognition as an example, students are guided to recognize 2D codes, character recognition, license plate recognition, and blood vessel segmentation. (2) After students complete the learning

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exploration task, the teacher releases the test questions on the teaching platform. Then students can complete the submission within the specified time using smartphones or computers. (3) Using the statistical analysis function with the software, students can immediately view data such as the average score, time spent, and the correct rate of each question. However, for questions with a high error rate, the teacher can promptly communicate with the students and help them analyze the reasons for their errors. (4) When the case is implemented, students can watch the operation explanation video on the computer to understand the basic knowledge used in programming and to deepen their understanding of the operation details. (5) After students finish each task, the teacher can guide them to master the skills of case implementation and summarizes the content of the task. Finally, students can log in to the teaching platform to summarize their performance and make comment on the teacher's class.

After the lecture, the teacher can post the post-lesson assignments on the teaching platform, and students can complete and submit them within a specified time. On the one hand, objective questions are automatically graded by the system through a pre-built question bank. On the other hand, subjective questions are manually graded by the teacher on the platform. For common problems in assignments, teachers can record lecture micro-lessons and push them to students. Students can watch the explanation videos online to review what they have learned. And at the same time, they can post their thoughts or questions on the teaching platform and exchange and discuss them online. According to the teaching activity data recorded by the teaching platform, teachers can better master the whole teaching process and prepare for subsequent lectures.

4.4 Using the collected learning data under the background of Internet plus and New Engineering to reform the assessment and evaluation system

The traditional Machine Vision curriculum assessment is based on a final exam or a single review paper writing. As the traditional assessment and evaluation mode is too single, the real level of students cannot be completely objectively evaluated. However, the data of the whole learning process of students can be collected and analyzed intelligently, which helps teachers to make better teaching decisions and evaluate grades.

Under the background of Internet plus and New Engineering, the assessment form of the Machine Vision curriculum can be combined with classroom assessment, regular homework assessment, and practical work assessment. A comprehensive assessment of the curriculum from many aspects can achieve diversified innovation. It enables students to be trained in many aspects. Through the assessment and evaluation system, students' understanding of machine vision principles and algorithms is better tested, and students' teamwork and practical innovation is better enhanced.

The proportion of classroom assessment, regular homework assessment, and practical work assessment in the Machine Vision curriculum is 20%, 20%, and 60% respectively. The classroom assessment is the classroom report and communication of students, which students' usual learning situation is evaluated. The usual homework assessment includes the usual homework training, which basic knowledge masted by students is evaluated. The practical work assessment with New Engineering concept is used to measure students' practical skills. In particular, the practical work assessment is a literature review and practical project design on a certain topic in groups of three or four students. For the practical work assessment, each group of students are required to cite at least 10 authoritative journal articles from the past five years, and to design different project proposals. In addition, they also need to analyze and complete them by programming. For example, in the case of "Machine Vision-based Metal Surface Defect Detection", students are required to read the literature according to the detection methods of different types of metal parts. Then they need to design and implement the project plan from both hardware and software aspects.

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5. Summary

In this paper, a new teaching reform model of Machine Vision curriculum is proposed under the background of Internet Plus and New Engineering. Firstly, the teaching mode of ideological and political education in the Machine Vision curriculum is increased, so that both knowledge learning and value leadership can be valued. Secondly, by using the change of learning space under Internet plus and New Engineering, the learning of machine vision content is integrated and enriched. It is beneficial for students to master the basic concepts, fundamental principles, and methods in machine vision. Thirdly, the "double main classroom" of the Machine Vision curriculum is built by means of various information. It is good for students to build their knowledge systems faster. Finally, the assessment and evaluation system of the Machine Vision curriculum is reformed by using the whole process of learning data collection. It allows for a more rational and comprehensive evaluation of students. In addition, as more attention is paid to applications in various industrial fields, students' practical and innovative ability is improved. Through the above reform exploration, for students in the major of mechanical and electronic engineering, they will be closer to achieve the goal of mastering machine vision algorithms and techniques, as well as applying machine vision technology to solve problems in the field of intelligent manufacturing.

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