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Exploring the Construction of the Course 'Image Processing and Computer Vision' for New Engineering Civil Engineering Majors from an Interdisciplinary Integration Perspective

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Abstract

This paper discusses the interdisciplinary integration construction of the course "Image Processing and Computer Vision" in the context of intelligent construction to adapt to the intelligent transformation of civil engineering majors in colleges and universities. This paper analyzes the status quo of the course system, emphasizes the importance of interdisciplinary education to cultivate composite talents, and puts forward the principles of course design, learning objectives and evaluation system. Detailed planning of theoretical foundation, technology application, scenario practice and knowledge integration modules, innovative teaching methods, such as project-driven, case study, virtual experiment and school-enterprise cooperation, are designed to enhance students' practical and innovative ability. Finally, the paper summarizes the conclusions and recommendations of the curriculum reform, emphasizing deepening interdisciplinary education, strengthening practical teaching, promoting school-enterprise cooperation and focusing on lifelong learning, with a view to cultivating professionals who will lead the future development of the construction industry.

Keywords

Interdisciplinary Integration; Intelligent Construction; Image Proessing; Computer Vision.

1. Introduction

With the rapid development of information technology and the global wave of digital transformation, intelligent construction, as an emerging construction model, is gradually becoming a key force to promote the innovation and upgrading of the traditional civil engineering industry [1].

Intelligent construction, as the name suggests, refers to the deep integration of advanced information technology, automation technology, artificial intelligence, big data analysis, and other modern technological means into the whole life cycle of design, construction, operation, and maintenance of a building in order to realize a construction process that is highly efficient, intelligent, and environmentally friendly [2]. Among the many application fields of intelligent construction, image processing and computer vision technologies play a crucial role. For example, in construction monitoring, high-definition cameras carried by drones capture on-site images [3,4], which are combined with image processing algorithms to automatically analyze construction progress [5,6] and safety compliance [7,8]. This greatly improves monitoring efficiency and accuracy. In building information modeling (BIM) optimization, computer vision technology assists in identifying the structural details of the model, helping designers to quickly correct errors, optimize the design, and achieve fine management [9]. Structural health

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assessment uses image recognition technology to perform non-destructive testing of building components, discover potential safety hazards in time, and ensure the long-term stability and safety of the structure [10].

In the face of the profound changes in the development of civil engineering in the new era, interdisciplinary integration education is particularly important. Traditional civil engineering education focuses on basic knowledge such as structural design and material mechanics, while in the era of intelligent construction, there is an increasing demand for knowledge in the fields of computer science, data science and artificial intelligence. Therefore, to cultivate professionals who can cope with the challenges of intelligent construction, it is necessary to break disciplinary barriers and achieve the deep integration of engineering technology and information technology [11]. As a typical representative of interdisciplinary education, the course "Image Processing and Computer Vision" can not only provide students with key skills such as analyzing complex engineering images and developing intelligent monitoring systems, but also stimulate students' innovative thinking, cultivate their ability to solve practical engineering problems, and deliver composite talents who are both civil engineering and information technology savvy to the field of intelligent construction.

In summary, this paper aims to explore how to deepen the construction of the course "Image Processing and Computer Vision" under the perspective of interdisciplinary integration to adapt to the development needs of the field of intelligent construction, provide practical paths and theoretical support for the modernization and transformation of civil engineering education, and ultimately help cultivate professionals who can lead the future development of the construction industry.

2. Analysis of Current Situation

In recent years, with the popularization of the concept of intelligent construction, many colleges, universities, and research institutions at home and abroad have actively responded by exploring the reform and innovation of intelligent construction-related education models. The research focuses on how to integrate information technology, artificial intelligence, and other cutting-edge technologies into the traditional civil engineering curriculum system in order to cultivate new engineering talents with cross-border capabilities [12]. Especially in the field of image processing and computer vision, some pioneers have tried to introduce it as an independent course or course module, allowing students to master the basic principles and application skills through a combination of theoretical lectures and practical operations [13].

Existing intelligent construction-related curriculum systems have demonstrated certain advantages, including but not limited to strengthening the integration of technology and engineering practice and enhancing students' technical application ability; promoting the initial cross-fertilization of disciplines and providing students with a broader perspective; and utilizing modern teaching methods and technology platforms to improve teaching interactivity and flexibility. However, there are also obvious shortcomings in these curriculum systems. First, the depth of interdisciplinary integration is insufficient, often staying only on the surface of curriculum splicing, and lacks systematic and deeply integrated curriculum design. Second, the practical teaching resources are limited, and there are fewer high-quality internships and practical training opportunities, which makes it difficult to meet the students' needs for learning about real work scenarios. Finally, the evaluation system is relatively homogeneous, focusing on the assessment of theoretical knowledge and neglecting the comprehensive evaluation of students' innovation ability and teamwork ability.

In view of the above shortcomings, the importance of interdisciplinary integration teaching in intelligent construction education has become increasingly prominent. First of all, the nature of intelligent construction determines that future civil engineers need to have interdisciplinary

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knowledge structures and skill sets, and interdisciplinary integration is the basis for cultivating such composite talents. Secondly, through the deep integration of information technology and civil engineering knowledge such as image processing and computer vision, the complex problems encountered in the practice of intelligent construction can be solved more effectively, and technological innovation and application can be promoted. Furthermore, with the abundance of online educational resources, the popularization of open source tools, and the application of virtual reality, cloud computing and other technologies, which provide technical support and convenient conditions for carrying out interdisciplinary teaching, the feasibility of interdisciplinary integration teaching is greatly enhanced.

In summary, although the current intelligent construction education has made some progress, it still faces problems such as the lack of deep interdisciplinary integration and the shortage of practical resources. Therefore, the construction of a more systematic and in-depth interdisciplinary curriculum system, especially the integration and optimization of key technology courses such as Image Processing and Computer Vision, is crucial for the cultivation of professionals who can adapt to the needs of the era of intelligent construction and is also an inevitable trend of educational reform.

3. Theoretical Foundations of Interdisciplinary Curriculum Construction

3.1. Discussion of Interdisciplinary Education Philosophy

The core concept of interdisciplinary education is to break the traditional boundaries of disciplines and promote the mutual penetration and integration of different knowledge fields to cultivate students' comprehensive literacy and innovation ability. This concept is particularly important in the context of intelligent construction, which requires the education system not only to impart in-depth knowledge of a single discipline but also to focus on the breadth and depth of multidisciplinary intersections, especially in combining key technologies such as image processing and computer vision with specialized knowledge in civil engineering.

3.2. Principles of Curriculum Design

The curriculum design should synthesize the multidisciplinary foundations of information technology, computer science, and civil engineering to ensure that students can understand and apply interdisciplinary knowledge to solve problems. In addition, rich practical sessions, such as project practice, virtual simulations, and field trips, are designed to incorporate real-life examples of intelligent construction to enhance students' real-world capabilities. By encouraging students to participate in research projects and innovation competitions, they can cultivate their critical thinking, innovative consciousness, and ability to solve complex engineering problems. Finally, the course content and teaching methods should have a certain degree of flexibility to adapt to the learning needs and interests of different students and promote the development of personalized learning paths.

3.3. Learning Objective

Students should master the basic theories, algorithms, and tools of image processing and computer vision and be able to apply these techniques in intelligent construction scenarios. At the same time, they should understand the basic principles of civil engineering and integrate information technology with civil engineering practices to solve real engineering problems. They should develop the ability to think and collaborate across disciplines, crossing the boundaries between technology and engineering to promote technological innovation. They should also develop the ability to self-learn and adapt to new technologies, laying the foundation for a long-term career.

3.4. Construction of the Evaluation System

Diversified assessment combines knowledge tests, program reports, peer reviews, and self-reflection to comprehensively assess the effectiveness of student learning. It focuses on the combination of process evaluation and outcome evaluation, considering both the performance and ability growth during the learning process and the quality of the final outcome. Evaluation focuses on practical operation, problem-solving, teamwork, and innovation rather than single knowledge memorization.

3.5. Strategies for Integrating Multidisciplinary Knowledge

The curriculum design adopts a modular structure, with each module focusing on a specific knowledge area and designing cross-module integrated application projects to promote the cross-fertilization of knowledge. For better implementation of co-teaching, we have formed a collaborative teaching team comprising experts in the fields of information technology, computer science, and civil engineering to co-design the course content. In addition, we have established cooperative relationships with smart construction-related enterprises and research institutions to strengthen practical teaching by introducing real project cases and providing internships and practical training opportunities. Finally, we utilize technological platforms such as cloud computing, big data, and artificial intelligence to provide students with advanced learning tools and resources to support interdisciplinary virtual experiments and data analysis.

4. Innovations in Course Content and Teaching Methods

4.1. Restructuring and Deepening of Course Content

In the Fundamentals and Theory module, we will carefully design a series of course content to ensure that students can have a solid grasp of the theoretical foundations of image processing and computer vision. First, we will start with the basic concepts of pixels, gray levels, color spaces, and image formats to lay the theoretical cornerstone of image processing. This is followed by an in-depth look at the application of mathematics and signal processing to image processing, including Fourier transforms, wavelet transforms, and other mathematical tools that are essential for understanding and implementing image processing algorithms. In addition, the theory of computer vision will be comprehensively covered, from the extraction and matching of image features to the algorithmic principles of object recognition and scene understanding. We will guide students to gradually master the core knowledge in this field. In particular, the application of deep learning in image processing will be the focus [14], introducing the power of Convolutional Neural Networks (CNNs) [15] in tasks such as image classification, object detection, and semantic segmentation, so that students can understand how to use deep learning frameworks such as TensorFlow and PyTorch to develop and optimize computer vision applications.

4.2. Deepening of the Technology Application and Development Module

The Technology Application and Development module will focus on developing students' practical skills so that they can translate their theoretical knowledge into real-world applications. We plan to familiarize students with commonly used image processing libraries such as OpenCV, as well as deep learning frameworks, by teaching them how to apply these tools. Through Python programming practice, students will implement classic algorithms such as edge detection, template matching, and feature point recognition, thus deepening their understanding of image processing techniques. In addition, the application of deep learning techniques will be thoroughly demonstrated, including how to build and train CNN models for complex image analysis tasks. This module will also cover intelligent construction scenario applications, such as construction monitoring, structural health monitoring, and safety and risk management. Through specific case studies and project practice, students will learn how to use these technologies in the field of intelligent construction.

4.3. Deepening of the Interdisciplinary Knowledge Integration Module

The Interdisciplinary Knowledge Integration module aims to develop students' interdisciplinary thinking and problem-solving skills. The course will integrate civil engineering principles, such as structural health monitoring, project management, and construction techniques, with the latest advances in data science and information technology, such as big data analytics, machine learning, the Internet of Things (IoT), cloud computing, and blockchain, so that students can understand how these technologies can work together in intelligent construction. Through this module, students will be able to see the key role that image processing and computer vision technologies play in intelligent construction and how they complement civil engineering knowledge to drive innovation and development in intelligent construction.

4.4. Innovative Teaching Methods and Practices

A range of innovative teaching methods will be employed to ensure that students fully grasp the course content and apply it in practice. Project-Based Learning (PBL) will be widely used. By designing intelligent construction projects, such as an automated construction monitoring system and drone-based structural damage assessment, students will learn and practice in a real project environment. Case studies and discussions will help students understand successful cases of intelligent construction and broaden their industry perspective through regular seminars and sessions with industry experts. We plan to provide students with a safe and efficient practice platform for construction safety training and construction process rehearsal through computer vision technology. University-enterprise cooperation and internship training will provide opportunities to work with intelligent construction companies, engage students in real-world projects, and encourage them to conduct original research and explore cutting-edge topics in intelligent construction related to computer vision.

4.5. Course Evaluation and Feedback Mechanisms

To ensure the quality of teaching and promote the holistic development of students, we will establish a comprehensive set of course assessment and feedback mechanisms. Formative assessment will be conducted throughout the semester to continuously monitor students' learning progress through group discussions, project progress reports, online quizzes, and more. Summative assessment will include project presentations, final exams, and peer reviews to comprehensively assess students' technical mastery and teamwork skills. The student feedback mechanism will regularly collect students' feedback on the course content, teaching methods, and practical sessions to continuously optimize the course design and ensure that the course keeps pace with the times and meets the demand for talent in the field of intelligent construction.

5. Conclusion

In this paper, we discuss in depth how to optimize the course of Image Processing and Computer Vision for civil engineering majors in colleges and universities through the perspective of interdisciplinary integration under the background of intelligent construction, to adapt to the urgent needs of the civil engineering industry's transformation to intelligence and informatization. We analyze the advantages and shortcomings of the current curriculum system, put forward the theoretical basis for constructing an interdisciplinary course, including the principles of course design, setting learning objectives, and constructing an evaluation system, and emphasize the importance of integrating multidisciplinary knowledge of

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information technology, computer science, and civil engineering. In terms of course content and teaching method innovation, we have planned in detail the modules of basic knowledge and theory, technology application and development, application of intelligent construction scenarios, and integration of interdisciplinary knowledge, and designed a series of innovative teaching strategies, such as project-driven learning, case studies, virtual experiments, and school-enterprise cooperation practical training, aiming to comprehensively improve students' practical ability and innovative thinking.

We summarize the suggestions for the construction of this course: First, universities should strengthen interdisciplinary education, build a cohesive interdisciplinary curriculum system, and promote the integration and exchange of knowledge among different disciplines. Second, increase the investment in practical teaching, establish intelligent construction laboratories with advanced hardware and software equipment, and provide students with abundant practical opportunities. Third, strengthen cooperation with enterprises to ensure that the curriculum content is closely aligned with the needs of the industry and enhance the employment competitiveness of students. Finally, focusing on the cultivation of students' lifelong learning ability, we regularly collect feedback and optimize the course content and teaching methods to continuously improve the timeliness and teaching effectiveness of the courses, and deliver high-quality talent to the field of intelligent construction.

In the face of the future of intelligent construction, civil engineering education must continue to innovate through the construction of an interdisciplinary integrated curriculum, to cultivate composite talents who are knowledgeable in both engineering technology and information technology, and to contribute to the development of China's and even the world's intelligent construction industry. This is not only a challenge for educators, but also a test for the education system, which requires the joint efforts of the government, colleges and universities, enterprises, and industry organizations to promote the cause of intelligent construction education to a new height.

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