

Teaching Reform and Practice of the Computer Vision Course in Universities under the Background of Emerging Engineering

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Abstract: The in-depth implementation of emerging-engineering construction has put forward new requirements for professionalism, practicality, and innovation in engineering course teaching at universities. Computer Vision is a core course for majors such as artificial intelligence, computer science, and software engineering, and it is also one of the core technologies most widely applied in the implementation of artificial intelligence industries. On this basis, this paper briefly analyzes the importance and current teaching status of the Computer Vision course teaching reform in universities under the background of emerging engineering, and explores innovative practical strategies for its teaching reform, so as to provide references for high-quality teaching of the Computer Vision course and the cultivation of emerging engineering talents in universities.

Keywords: Emerging engineering; Computer Vision course; Teaching reform

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1. Introduction

Computer Vision is an interdisciplinary course integrating disciplinary knowledge of digital image processing, machine learning, deep learning, mathematical modeling, and other fields, and it is widely applied in many fields including intelligent manufacturing, smart transportation, and medical imaging. Under the background of emerging engineering, carrying out teaching reform for the Computer Vision course is not only an inevitable requirement for meeting the demands for compound engineering-technical talents brought by the rapid development of artificial intelligence industries, but also an important starting point for promoting the transformation of the course from traditional theoretical lecturing toward interdisciplinary application-oriented teaching^[1]. Therefore, starting from the core connotation of emerging engineering construction, this paper carries out research and practice on the teaching reform of the Computer Vision course, and constructs a teaching system integrating four dimensions: theory, practice, innovation, and education, so as to facilitate the high-quality cultivation of emerging engineering talents in universities.

2. Importance of teaching reform for the Computer Vision course in universities under the background of emerging engineering

2.1. Matching the talent training orientation of emerging engineering

Emerging engineering construction emphasizes three curriculum construction criteria: higher-order thinking, innovation and challenge degree, and focuses on interdisciplinary integration, engineering practice implementation, and innovation ability cultivation. With strong theoretical nature, practicality, and cutting-edge features, the Computer Vision course constitutes an important part of the emerging engineering talent training system. Traditional course teaching focuses on imparting theoretical knowledge such as basic image processing, formula derivation, and principle explanation of traditional visual algorithms. It lacks higher-order content such as deep learning, scenario-based application, and engineering optimization. Besides, insufficient difficulty and gradient of courses create a certain gap with the construction criteria of emerging-engineering courses^[2]. Through teaching reform, reconstructing the knowledge system and teaching mode of the Computer Vision course can realize the organic unification of knowledge imparting, ability cultivation, and value shaping, and conform to the training objectives for compound and innovative engineering talents of emerging engineering.

2.2. Promoting interdisciplinary integration of course teaching

Facing core features of emerging engineering construction such as disciplinary intersection and cross-border integration, the teaching of the Computer Vision course shall break barriers among majors including computer science, automation, mechanical engineering and measurement control technology, and strengthen the construction of teaching systems for interdisciplinary integrated application. Relying on teaching reform, teachers integrate scenario demands, industrial rules, and business logic of relevant professional fields into course teaching, supporting students of different majors to carry out visual technology application practices combined with their own major orientations^[3]. Meanwhile, modular teaching units are built for different integrated application directions. On the basis of teaching principles of core visual algorithms, teachers incorporate industrial background knowledge and typical project cases of corresponding fields, and encourage students from different majors to form teams for completing interdisciplinary practical projects. This helps students deepen their understanding of technologies in interdisciplinary integrated application scenarios, promotes the transformation of the course from a pure theoretical course toward a core interdisciplinary application-oriented course, and improves course construction quality^[4].

3. Current teaching status of the Computer Vision course in universities

3.1. Slow update of the course teaching system

Computer vision belongs to a cutting-edge technical field with rapid iteration. It ranges from classic algorithms such as SIFT feature extraction, HOG detection, and threshold segmentation to new deep learning technologies including convolutional neural networks, Transformer visual models, and multimodal visual fusion, featuring short technical update cycles and fast iteration speed. Nevertheless, textbook contents for the university Computer Vision course are usually updated slowly. Cutting-edge content such as deep learning, state-of-the-art models, and engineering optimization mainly depends on teachers' in-class expansion. At the same time, the design of the current course knowledge system lacks systematicity; theoretical knowledge points are fragmented, and logical connections between different knowledge points

are relatively stiff. A complete gradient from classic algorithms to cutting-edge technologies and from basic principles to engineering implementation has not been formed ^[5]. Comprehensive experiments are not only arranged at the end of the course, but also lack practical content related to industrial scenarios and industrial pain points. As a result, students can hardly flexibly apply learned knowledge to solve visual problems in real-world scenarios.

3.2. Rigid and single classroom teaching mode

At present, classroom teaching of the Computer Vision course in many universities still mainly focuses on theoretical formula derivation and principle explanation. Abstract and obscure mathematical principles and algorithm models make many students feel daunted. On the one hand, classroom interaction forms are relatively single. Interactive and inquiry-based teaching activities such as group cooperation, case decomposition, and project-based exploration are insufficient. Students stay in a passive knowledge-receiving environment for a long time, so their abilities of independent thinking and innovation cannot be effectively cultivated ^[6]. On the other hand, hierarchical teaching design is absent in classrooms. Teachers usually adopt a “one-size-fits-all” teaching mode, failing to satisfy the learning demands of students with varied foundations and professional backgrounds. Some students with weak foundations cannot keep up with progress and gradually lose learning enthusiasm and initiative, while students who are highly interested in computer vision and have spare learning capacity cannot get their demands for in-depth learning met. Classroom teaching efficiency and educational quality are greatly compromised.

3.3. Formalistic industry-education integration education

Emerging-engineering talent cultivation relies heavily on industry-education integration and school-enterprise collaboration. However, many current school-enterprise cooperations are limited to superficial forms such as enterprise lectures and short-term visits, without forming normalized cooperation mechanisms for joint project construction, co-cultivation of teaching staff, and resource sharing. Industrial experts do not participate in teaching design, content updating, and project guidance for the Computer Vision course, so campus teaching cannot accurately match enterprise post standards and technical demands ^[7]. Meanwhile, course projects in universities are disconnected from real enterprise production projects. Students lack practical project experience in real enterprise scenarios and have insufficient understanding of development workflows, technical standards, and optimization difficulties of real-world industrial vision projects. Consequently, students need a long adaptation period to meet practical enterprise development requirements after taking up posts, and a seamless transition from graduation to employment cannot be realized.

4. Innovative practical strategies for Computer Vision course teaching under the background of emerging engineering

4.1. Optimizing teaching contents and building a hierarchical and progressive knowledge system

Based on the emerging engineering requirements for higher-order thinking, innovation, and challenge degree, teachers of the Computer Vision course shall redesign the course content system combined with the update speed of industrial technologies and changes in post demands, break the constraints of traditional textbook contents, and realize dynamic updating and accurate matching of teaching contents. In practical

teaching, teachers may divide course contents into four modules: basic theory, core algorithms, cutting-edge technologies, and engineering application.

The basic theory module retains core fundamental contents such as digital image processing, basics of visual perception, and matrix operations, aiming to help students lay a solid theoretical foundation and build a systematic and complete knowledge system [8]. The classic algorithm module focuses on principles, workflows, and application scenarios of traditional visual algorithms, such as image segmentation, feature extraction, object matching, and image filtering, and imparts underlying logics of visual technologies to students. The cutting-edge technology module mainly adds deep learning vision-related content, including mainstream technologies such as convolutional neural networks, Transformer visual models, image segmentation algorithms, and lightweight model deployment. The engineering application module combines application scenarios of various industries such as intelligent manufacturing, smart transportation, medical imaging and security monitoring, and introduces real-world cases including industrial defect detection, real-time object tracking, face recognition and image super-resolution reconstruction [9]. While learning technical principles, students can grasp application essentials in different scenarios and establish corresponding connections between theoretical knowledge and practical application. In addition, teachers shall eliminate obsolete knowledge points in a timely manner and add the latest industrial technologies, enterprise project cases, and technical difficulties to realize dynamic updating of teaching contents.

4.2. Innovating teaching modes and building blended immersive classrooms

Before class, teachers upload learning materials such as courseware, algorithm explanation videos, open-source tutorials, and cutting-edge literature via online teaching platforms such as MOOCs, Xuexitong, and professional knowledge bases. Pre-class preview tasks are assigned to require students to independently learn basic knowledge points and sort out difficult problems, so as to cultivate students' independent learning abilities [10].

During formal classes, teachers adopt teaching methods including problem-driven instruction, case decomposition, practical demonstration, and group seminars, and give targeted intensive lectures aiming at difficult problems encountered by students in preview. For example, when learning content related to convolutional neural network-based image classification, teachers raise a real-scenario question: "How to realize automatic classification of products with different defects on industrial assembly lines?" Students are guided to discuss solutions in groups combined with pre-class knowledge. Based on discussion results, teachers decompose structural principles, training workflows, and parameter-tuning skills of convolutional neural networks, and finally lead students to complete practical training of small-scale classification models in class [11].

After class, teachers assign hierarchical expansion tasks according to students' varied foundations and professional backgrounds. Students are required to develop small-scale application projects based on in-class knowledge points combined with their own major orientations, submit project deliverables on online platforms, and carry out mutual evaluation and communication. Teachers provide one-on-one Q&A and guidance aimed at problems existing in students' projects. This blended immersive teaching mode breaks spatiotemporal limits of traditional classrooms, transforms knowledge receiving-oriented classrooms into immersive learning scenarios for active exploration and interactive communication, and can effectively

exercise students' abilities of independent learning, problem-solving, and teamwork.

4.3. Improving the practical training system and building a full-process engineering education platform

From the perspective of emerging engineering, practical teaching of the Computer Vision course in universities shall solve previous problems of fragmentation and superficiality, match practical ability cultivation demands of students at different stages, and comprehensively cultivate their engineering practice and innovation capabilities.

For instance, teachers can build a hierarchical practical teaching workflow relying on real-world industrial vision detection projects. For freshmen or students with weak foundations, practical training platforms are adopted to carry out basic practical exercises such as image reading, gray-scale transformation, filtering and denoising, and edge detection. Students are trained to skillfully invoke basic OpenCV tools and master principles of core image processing algorithms to consolidate underlying practical skills^[12].

For students with certain foundations or in intermediate-to-advanced learning stages, teachers organize students in groups to undertake comprehensive project tasks such as component defect identification and object positioning. Students are required to independently complete collection, cleaning, annotation, and augmentation of image datasets, build and fine-tune lightweight convolutional neural network models, and finish algorithm debugging, performance optimization, and result verification^[13].

At the same time, teachers can connect with industrial implementation demands and carry out practical training for on-device model deployment. Students are guided to complete model conversion, adaptive debugging, and real-scenario testing based on development boards. They independently finish the whole process, including project scheme design, code writing, problem troubleshooting, and practical training report writing. Students can receive full-process practical training for computer vision projects ranging from data processing and algorithm development to implementation and application on campus, further expanding the coverage and depth of practical training cultivation.

4.4. Deepening school-enterprise collaboration and improving the industry-education integration education mechanism

Universities shall cooperate with partner enterprises to build normalized and substantial industry-education collaborative education mechanisms, enabling enterprises to truly participate in the whole process of course construction and talent cultivation.

First, universities can set up a course teaching, research and development team composed of professional teachers and enterprise technical backbones. They jointly sort out ability requirements for posts corresponding to the Computer Vision course, transform the latest enterprise technical standards and real-world project demands into teaching contents, and jointly develop course handouts, project cases, and practical training question banks that fit industrial realities, ensuring that teaching contents keep pace with industrial technology development^[14].

Second, build a school-enterprise dual-qualification teaching team. Enterprise visual technology engineers and project principals are hired as enterprise tutors to give lectures on cutting-edge technologies, guide enterprise projects, and interpret industrial standards. This makes up for the deficiency of industrial practical experience among on-campus teachers and realizes complementary advantages between university teachers and enterprise tutors.

Third, jointly build practical training education bases. Off-campus practical training bases are established relying on enterprise industrial vision project resources. Students are organized to take phased enterprise practical training and participate in real-world project practice. They are deeply involved in the whole process of enterprise project development, debugging, and implementation, accumulate development experience of real-world industrial projects, and get familiar with technical requirements, collaboration specifications, and problem-solving ideas in industrial scenarios ^[15].

Finally, universities can carry out targeted talent cultivation. Combined with enterprise talent demands, customized course teaching schemes and practical training projects are formulated to realize seamless connection among course teaching, project practical training, and post employment, and improve pertinence and adaptability of talent cultivation.

5. Conclusion

Under the background of emerging engineering construction, the teaching reform of the Computer Vision course shall aim at cultivating compound and innovative engineering technical talents. Based on the industrial feature of rapid iteration of computer vision technologies, practices such as constructing hierarchical and progressive knowledge systems, building blended immersive classrooms, establishing full-process engineering education platforms, and improving industry-education integration education mechanisms shall be implemented to continuously enhance course teaching quality. More high-quality engineering technical talents meeting industrial development demands are cultivated for China's artificial intelligence field.

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