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A Learning Factory Framework: Project based Learning for Machine Learning Course for Chinese Polytechnic Students

Xinfeng Chen, Chuanzheng Xie

Wenzhou Polytechnic, Wenzhou 325000, China

Abstract

This paper demonstrate machine vision competency and future working requirement in factory. A high-level machine vision technic school students are high demand by enterprise due to intelligent manufacturing transformation and revolution. In order to encounter the requirement of the manufacuturing demand, the proposed teching method which bases factory real project, to develop students problem solving skills and teaching project experience are implemented within university and factory. This experimental teaching method improved stdudents high perfomance in factory and enhanced competence of students in machine vision career.

Keywords

Machine Vision; Learning Factory; Non-Contact Measurement; Quality Meeasurement.

1. Introduction

Machine vision is being more widely used across various industrial applications. Developing these applications requires integrating knowledge from multiple disciplines and identifying potential areas where machine vision can be applied [1]. Under the background of intelligent manufacturing transformation and upgrading, machine vision technology has been widely applied due to its advantages of fast detection speed, high detection accuracy, low detection cost, ease of automation, and information networking. By utilizing machine vision technology, key dimensions of products can be measured, defects can be detected, and the presence or absence of certain features can be judged, along with other semantic segmentation tasks, to obtain production data for each product and improve the efficiency of production lines. As an important branch of artificial intelligence, computer vision technology is characterized by rapid technological updates and interdisciplinary integration. Moreover, from 2016 to 2020, the market size of China's computer vision industry has consistently maintained a high growth rate. The expansion of the computer vision market has led to an increasing demand for talent in this field. Therefore, higher vocational institutions, as the main force in cultivating applied talents, urgently need to focus on the construction and reform of computer vision courses. In the coming years, the "Visual Technology and Applications" course will be upgraded from an elective to a mandatory course with increased class hours, significantly raising the demand for high-quality teaching resources for these courses. Additionally, the development of automation equipment for computer vision, feeding research back into teaching, has significant implications for improving the content of the machine vision course, enhancing teaching capabilities, and improving the quality of student training.

Teaching and research are the two fundamental functions of higher education institutions. In the new era, higher vocational education demands that vocational colleges cultivate high-quality technical and skilled personnel who can meet the needs of regional economic development. In addition to having substantial teaching skills, teachers at vocational colleges must also possess a high level of academic expertise. Integration of teaching and research is a fundamental characteristic of modern universities, which is called learning factory as well. The

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learning factories at universities sheds light on their development and the various designs implemented across institutions. While the concept of learning factories has been around for some time, its widespread adoption has only become noticeable in the past decade. This trend has been supported by numerous publications and the establishment of various scientific networks. The increasing number of learning factory initiatives and their growing visibility present significant potential for the concept. The quantitative study indicates that learning factories are gaining popularity at universities, both in terms of their dissemination and the range of engineering topics they cover. Besides technical subjects, there is also some integration of business-related content[2].

2. Research Problem

Based on the teaching content and talent cultivation plans, align with regional economic development, conduct research to identify suitable automation production enterprises, engage with key technical personnel in these enterprises, understand the application scenarios and principles of vision technology, and develop appropriate teaching resources.

Based on actual business needs, implement practical application teaching that includes circuit assembly, software programming, and other related areas.

Utilize research platforms to guide students in participating in various scientific and technological competitions and innovation and entrepreneurship contests, achieving comprehensive improvement in students' abilities through project design and development, application, and innovation and entrepreneurship.

3. Research Problem

3.1. Curriculum Content Innovation: Integration of Teaching, Textbooks, Teaching Methods, and Research Projects

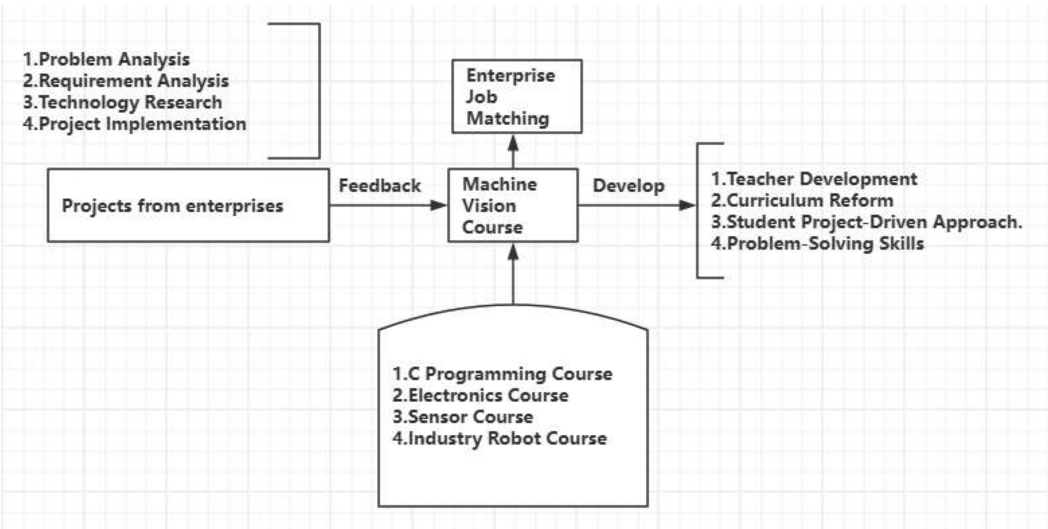

Fig. 1 learning factory framework

First introduced in 1994, Learning Factories (LFs) have gained popularity since the mid-2000s. LFs are factory models that simulate real industrial processes and technologies, providing practical insights based on actual industrial applications [3]. Since the proliferation of these tools began in 1994, Learning Factories (LFs) have increasingly been categorized based on the processes and products they address and the educational and research objectives they aim to achieve. Consequently, it is challenging to determine what research and teaching applications can be derived from LF environments, what competencies they can foster, and what learning

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content can be developed from the implemented processes and technologies [4]. In figure 1, a learning factory framework is demonstrated. Most of projects are identified by enterprises, which feedback the entire relevant machine vision course. Meanwhile, students get experience in this while systematical project which include programing, electronics, sensor knowledge. In the result, from the whole framework, teachers and students acquire high-level skills such as machine vision algorithm, programming skills, problem-solving skills.

As illustrated in Figure 1, integrating research projects into teaching activities involves incorporating real research project cases into existing textbooks, allowing students to engage in actual research projects based on traditional computer vision technology theory. This will demonstrate the practical applicability of the course, update textbook content, course content, and teaching methods based on real projects.

3.2. Talent Development: Skills and Competencies Meeting Enterprise Job Requirements

Applying knowledge to practice and integrating theory with practice is essential. Traditional computer vision technology training often focuses on basic image processing skills such as binarization, threshold segmentation, and contour recognition, lacking real-world application. Students are usually passive recipients and may struggle to develop image processing strategies when faced with actual detection environments. By incorporating research topics, horizontal projects, and competition projects into teaching, and clarifying project content and goals, students' technical skills can be enhanced through project requirement analysis, UI design, circuit assembly, and development and debugging of visual image processing. Establishing a scientific feedback mechanism and multiple feedback channels contributes to the integrated development of research and teaching, and is crucial for cultivating innovative talents and stimulating their potential. As vocational colleges focus on applied talent cultivation, it is important to understand enterprise needs and the level of knowledge or skills required during project implementation, rather than merely using traditional rote teaching methods.

3.3. Utilizing Research and Development Outcomes for Practical Training

Leverage the results of research projects and horizontal projects by using existing computer vision inspection workstations in the "Applications of Computer Vision Technology" course. Allow students to trace back through the project development process to master the design and development workflow of vision technology equipment. This includes visual software UI design, circuit assembly and debugging, use of industrial cameras, and development of visual image processing systems. This approach aims to enhance students' project application skills and problem-solving abilities, enabling them to integrate more quickly into enterprise projects after graduation.

3.4. Using Collaborative Research Platforms to Enhance Student Skills

Take advantage of the research platforms built through teacher-student collaboration to guide students in participating in various scientific and technological competitions and innovation and entrepreneurship contests. This will cover the entire spectrum from project design and development to project application and innovation and entrepreneurship, thereby comprehensively improving students' skills and capabilities.

3.5. Establishing a Teacher Team for Visual Technology R&D based on Enterprise Projects

For visual technology equipment development related to enterprise projects, a multidisciplinary and multifunctional teacher team needs to be established. Team members with diverse expertise and skills should collaborate to handle multiple tasks and coordinate hardware functionalities. The team will work together on the enterprise research projects,

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complete the tasks, and convert the research outcomes into teaching resources, enriching the curriculum with practical content and real-world examples.

3.6. Establishing a Student Team for Visual Technology R&D based on Enterprise Projects

Form a student team for visual technology R&D based on the goals of completed projects. The student groups will collaborate, manage specific module tasks, and engage in learning and training. Starting with imitation learning, students will actively participate in brainstorming sessions, foster innovative thinking, and enhance their ability to integrate theory with practice. This approach will help students understand the requirements of real projects better and improve their problem-solving skills.

3.7. Establishing Retrievable Learning Resources on an Online Course Platform

Given the complexity of enterprise-related content, classroom teaching can only cover a portion of it. To enhance the quality of student learning and provide opportunities for all levels of students, relevant content should be uploaded to an online course platform in modules. Learning progress restrictions will be set, and interactive online-offline teaching will be used to motivate students to engage in both in-class and extra-curricular learning. Advanced students will receive guidance for further innovation, while those who are struggling will be given opportunities for supplementary learning.

4. Research Result

Machine vision is being increasingly utilized across various industrial applications. Developing these applications requires a blend of expertise from multiple disciplines and the identification of potential areas for application [1]. students work on practical research projects such as “Research on Leather Cutting Technology Based on Machine Vision,” “Design and Implementation of Visual Inspection and Traceability System for Clutch Production Line,” and “Development of Leather Cutting Technology Equipment Based on Computer Vision,” which are vertical research projects which comes from real enterprise projects. Thus, the machine vision course no longer be just an independent theoretical course; it becomes interdisciplinary, integrating with basic C language, electrical and electronic technology, sensor technology, and industrial robotics technology. Most students get high experience in factory projects, and some of students get employment from enterprises.

5. Conclusion

The paper highlights future machine vision development and requirements from factory and demonstrates how project-based learning factories can be an effective method for acquiring these competencies. It proposes an approach grounded in learning theories, methods, and the specific features of the learning methodology. This learning framework was developed to address various necessary competencies.

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