Education Reform and Development, 2024, Volume 6, Issue 5
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Embedded Technology Teaching Research and Practice under the Model of Integrated Discipline Competition Project

Baihua Li*

Hefei University of Economics, Hefei 230031, China

***Corresponding author:** Baihua Li, 18756961493@163.com

Abstract: Embedded technology and application, as the core course of the electronic communication major, is an important professional course for students to engage in embedded software and hardware development in the future. Given the difficulty of embedded courses in theory and the high requirement of practical ability, this paper takes the title of the National Electronic Design Competition for College Students as the content of embedded course research project, carries on the innovation and reorganization of embedded course content, integrates multidisciplinary knowledge, and enhances students' understanding ability and practical ability from the perspective of practice. At the same time, the use of modern information education resources, the introduction of online video teaching resources, and the use of learning platforms allow supervision of students' learning progress and effect. The teaching practice shows that this teaching model, which integrates competition topics into theoretical learning and project practice, effectively promotes students' interest in participating in discipline competitions and enhances their recognition of majors and professions.

Keywords: Discipline competition; Embedded technology and application; Information-based teaching

Online publication: June 20, 2024

1. Introduction

The development of embedded technology is closely related to chips, sensors, networks, and terminal devices in the Internet of Things industry chain. In today's highly modern and intelligent era, embedded systems play an increasingly important role as a bridge connecting the physical world and the digital world [1–2]. Embedded technology not only covers the deep integration of hardware and software but also involves the cross-application of multi-disciplinary knowledge. In this context, the talents engaged in embedded development need to have a strong sense of time and innovation. As a practical and innovative education model, discipline competition provides a broad platform for the learning of embedded systems and the cultivation and development of talents [3]. Through competition, students can transform theoretical knowledge into practical application, exercise their problem-solving ability, and stimulate their innovative thinking to solve the problems of multi-disciplinary integration.

The National Electronic Design Competition for College Students is a national class discipline competition

platform. The topic design examines students' comprehensive ability in electronic information from many aspects, such as theoretical consideration, hardware circuit design, and software algorithm optimization. This paper takes the 2023 competition control topic as an example, in which the competition achieves the function of the decomposition of the effectiveness of the project module, the module knowledge, and embedded technology and application course teaching combination so that students understand the embedded electronic product design process, thus intuitive exploring with a higher level of electronic system products. The use of learning in classroom teaching, the use of information teaching means to record and supervise the learning effect of students, and the use of case-driven teaching methods can enhance students' theoretical knowledge level and improve their discipline competition ability [4].

2. Teaching design

According to the requirements of the competition, students need to design a moving target control system and an automatic tracking system, which are independent of each other. The target control system has a reset function, requiring the tape to move clockwise for one week without disconnecting, in which the target paper is attached to any position on the screen at any rotation angle [5]. After the target position is reset, the one-click automatic tracking system can track the target within 2 seconds and the distance is less than 3 cm, and both the target control system and the automatic tracking system need to set the pause button.

2.1. Project hardware design

To design and realize the functions of the control system, the target control system is based on OpenMV and adopts PID control, module recognition, color recognition, image processing, and other technologies and methods to design a PTZ system that can track the target object dynamically [6]. The automatic tracking system is based on the K210 chip target coordinate output, first according to the camera feedback image will be defined as a plane X and Y axis, and then identify the position of the red spot in the picture, and finally through the K210 chip output position coordinates to STM32F03C8T6, to achieve the automatic recognition and tracking of the red spot [7]. The design uses 3D printing technology, which is novel, can accelerate progress, and reduce cost, in addition to the more humanized system-installed voice module. The hardware block diagram of the design system is shown in **Figure 1**.

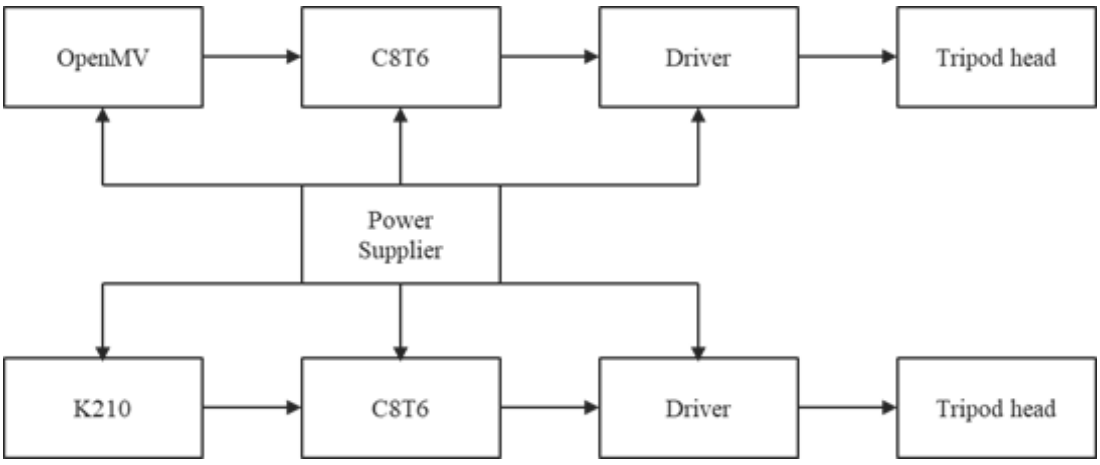

Figure 1. Overall block diagram of system hardware

According to the overall hardware block diagram designed by the topic, the competition knowledge can be decomposed into a microprocessor module, camera driver module, power supply module, steering gear driver module, and PTZ design module [8]. In the hardware design, the microprocessor is a 32-bit processor with embedded technology, and the kernel is Cortex-M3 series. The power supply module provides a 3.3 v stable voltage for the processor, and the image processing module uses a USB port for the power supply to ensure the normal working of the two modules. USART communication mode is used for the communication between microprocessing and the camera, and the image data collected by the camera is filtered. K210, as the processor core of the tracking system, uses I2C communication mode to communicate with the microprocessor. The servo drive module uses the PWM output function in the timer function of the microprocessor to convert the position coordinates into the time correspondence of the high level of PWM waveform, control the rotation of the PTZ, and track the target.

To increase the innovation of the system design, students in the design of the topic use 3D printing technology to print out a two-dimensional head. This innovative design point reflects the student's ability to solve problems across disciplines. In embedded technology and application course design, interdisciplinary integration, combined with intelligent manufacturing and artificial intelligence disciplines, achieves the realization of embedded artificial intelligence functions and multi-disciplinary integration to provide new ideas [9].

2.2. Project software algorithm design

First of all, OpenMV and K210 annotate black rectangular boxes through image acquisition, use color recognition to annotate laser points, and then use the Kalman filter to filter out clutter. The image processing module packages the four vertex coordinates and laser point coordinates of the rectangular frame through the serial port and sends the data frame to STM32. The coordinate points are determined to control the steering gear to move in the specified direction to realize the identification and tracking of the PTZ (**Figure 2**).

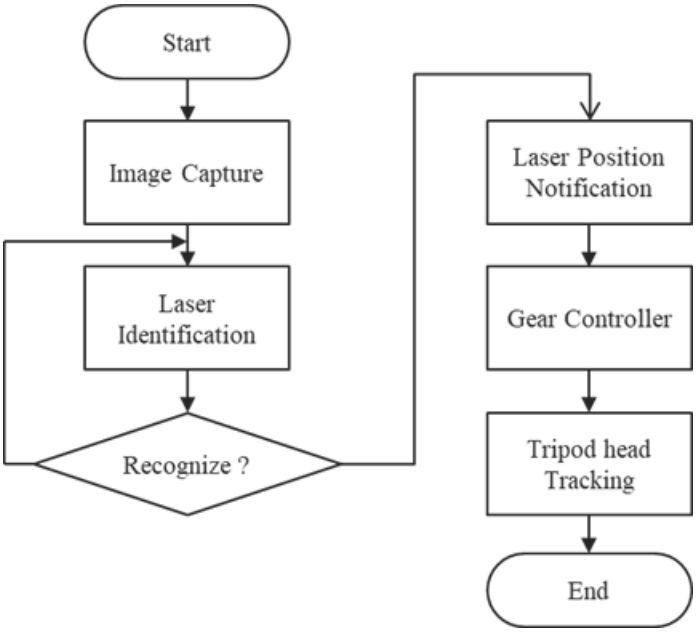

Figure 2. Software algorithm design flow chart

The control algorithm uses the PID algorithm. PID algorithm control precision is high, and the algorithm is simple and clear. The control of this system is accurate enough, saving the resources and computing time of the single-chip microcomputer. Moving target control through the frequency of 50 HZ duty cycle of 2.5%–5%

(corresponding to 0–180° PTZ) square wave signal to achieve the control of the steering gear PTZ [10]. Tracking performance analysis through the serial port like the upper computer to send the current servo motion waveform and observe the current target tracking state on the screen, if the target is successfully pursued, to determine whether the current tracking performance is good or bad, and then adjust the PID parameters.

In the software design, the driver development of the basic module is based on the embedded C language, which drives each module to work normally. The class design focuses on the students' programming control of each module, the programming of the communication module, the setting of the PWM waveform, and the realization of the PID algorithm. Through the fast setting of the module, students can master the basic code of the driving setting and deepen their understanding of the algorithm.

3. Teaching implementation

3.1. Online class

Educators can send project-based knowledge modules to students using the learning-connect platform, and test students' understanding of theoretical knowledge through in-class quizzes [11]. Educators would set software programming questions for each module of the experimental course, observe the students' experimental results, and evaluate and score the students' experimental results. The online learning activities are shown in **Figure 3**.

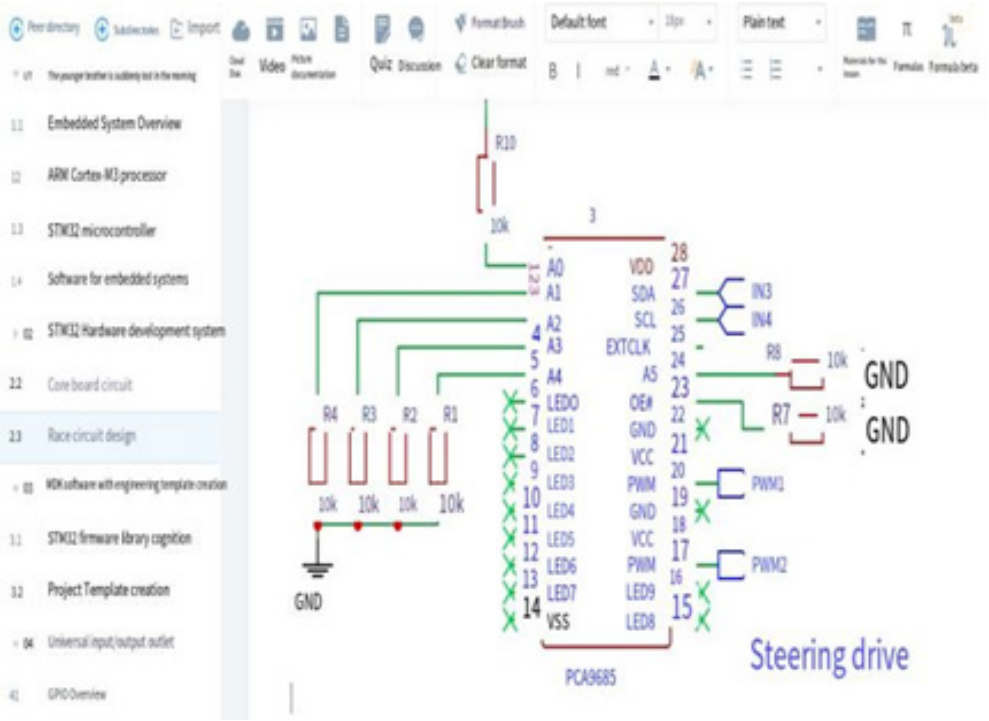

Figure 3. Learning through the online learning activity settings

3.2. Offline classroom

The introduction of online teaching resources can promote students' understanding of theoretical and experimental content. Offline classes focus on students' mastery through classroom tests, thematic discussions, questionnaires, and other activities [12]. Students participate in activities to get points according to the difficulty of the question. The combination of online and offline modes can not only mobilize the enthusiasm of students but also facilitate teachers and students to grasp the learning situation.

3.3. Political ideology in class

To integrate political ideology into the classroom, ideological and political elements are added to the classroom settings to guide students to think about the philosophical elements in engineering education during the introduction of classroom competition projects. The teaching method of ideological and political education in the course adopts a practical teaching method. In practice teaching, embedded technology is used as a tool to allow students to think and solve social problems, inspiring students' innovative thinking.

The ideological and political elements in practical teaching activities are mainly the combination of the principle of interruption and contradictory thoughts [13]. Interrupt is a very key concept in project software design. Students need to realize the communication between microcontroller and peripherals by interrupt based on understanding the theory, to improve the efficiency of the system. When multiple peripherals apply for interrupt, the interrupt controller needs to determine which external has a priority, and the priority needs to be set for external devices. In the ideal of dialectical materialism, the world of motion is full of contradictions. Among the many contradictions, students must be good at grasping and solving the main contradiction [14].

4. Conclusion

Given the common problems in embedded technology and application teaching, such as difficult theory and weak practical ability of students, this paper introduces the project content of the electronic design competition for university students in classroom teaching, disassembles the task of the competition into modules, and integrates them into classroom teaching activities. The teaching model is mixed online and offline, the students' grasp is inspected in time, and the theoretical teaching and practical teaching are assessed in the process [15]. In the process of teaching implementation, ideological and political elements are introduced to guide students to think about social problems and inspire students to solve problems with innovative thinking. The practice results show that the students' theoretical knowledge level is improved, their interest in participating in the competition is improved, and their practical ability is improved. In recent years, students have made great progress in participating in the Anhui robot competition, the National Electronic Design Competition for College Students, and other professional discipline competitions, winning second prize and three third prizes respectively.

Funding

Project 1: Provincial Quality Project of Colleges and Universities in Anhui Province in 22nd year, project number: 2022xsxx179.

Project 2: Provincial Quality Engineering-Communication Engineering Traditional Major Transformation and Improvement Project of Anhui Provincial Colleges and Universities in 2012, project number: 2021zygzts051.

Disclosure statement

The author declares no conflict of interest.

References

[1] Peng YH, Cheng L, 2021, Embedded Teaching Reform and Practice Integrating Maker Education Model. Journal of North China University of Science and Technology (Social Sciences Edition), 21(3): 86–90.

[2] Ma WL, 2021, A Study on the Cultivation of Engineering Talents in "Course-Project": A Case Study of MIT and

Eurasia Institute of Technology. Journal of Beijing University of Aeronautics and Astronautics (Social Sciences Edition), 34(6): 148–155.

[3] Liang R, 2024, Design of Moving Target Control and Automatic Tracking System Based on Embedded Technology. Integrated Circuits and Embedded Systems, 24(1): 89–93.

[4] Liu YT, Dong MC, Huang JC, et al., 2019, Design of Target Tracking System based on OpenMV. Journal of Nanjing Institute of Technology (Natural Science Edition), 17(1): 1672–2558.

[5] Wang ZC, Zeng WP, Huang G, 2019, Design and Manufacture of Intelligent Car based on OpenMV Image Recognition. Electronic World, 2019(24): 143–144.

[6] Zhang JH, Chen XW, He A, 2022, Research on Information Teaching of "MCU Principle and Embedded System" under OBE Concept. Industry and Information Education, 2022(3): 44–48.

[7] Zhang J, Zhu YX, Hu J, et al., 2022, Design of Embedded Teaching Model of Scientific Research "Golden Course": Taking "Satellite Communication" Course as an Example. Industrial and Information Education, 2022(6): 5–8.

[8] Zhang HW, Wang XH, Wang J, 2021, Research on Ideological and Political Resources Mining and Teaching Methods of "Embedded System Design" Course. Industrial and Information Education, 2021(3): 60–63.

[9] He T, Jia P, Li GW, et al., 2024, Meteor Optical Monitoring System based on Embedded Artificial Intelligence Equipment. Acta Astronomica Sinica, 65(01): 55–68.

[10] Liang R, 2019, Design of Moving Object Control and Automatic Tracking System based on Embedded Technology. Integrated Circuits and Embedded Systems, 24(01): 89–93.

[11] Yan WJ, 2023, Research on Teaching Practice of Embedded Technology Application from Ideological and Political Perspective. Education and Teaching Forum, 2023(50): 53–56.

[12] Su YS, 2023, Application of Big Data Embedded Software in Internet of Things Technology. Information and Computer (Theoretical Edition), 35(23): 100–102.

[13] Zhang M, Chen SZ, Xu K, et al., 2024, Research on Airborne Embedded Data Security Technology based on TEE. Electro-optics & Control, 31(01): 87–91.

[14] Han X, Lu J, Yu L, 2023, Innovation and Construction of Flipped Classroom Teaching Model in Colleges and Universities based on Embedded Technology. Journal of Heihe University, 14(10): 94–96.

[15] Hu YK, Kong LY, Hou CL, et al., 2023, Embedded System Course Teaching Reform Practice under the Background of School-Enterprise Cooperation: A Case Study of Guangdong Polytechnic of Industry and Trade. Fujian Textile & Textile, 2023(10): 71–74.