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Exploration and Practice of Sensor Teaching Reform Under Subject Integration

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Abstract: Through the design of three major projects, the different subjects we had previously learned are integrated together such as electronic technology, C language, and single-chip technology. In-depth study of sensor courses at various levels allows students to break through the boundaries between disciplines of the subjects to learn the application of sensors and related new technologies. Establish an overall engineering viewing will comprehensively improve the comprehensive ability of students.
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Sensors plays an important role in the recent development. From aerospace to smart homes, from production and office to daily life, the applications of sensors have penetrated into all aspects that we are familiar with or unfamiliar with, which is indispensable useful for improving the quality of our lives and improving environmental safety. This subject is also highly professional and comprehensive, and it is a required course for many engineering majors.

Our school offers the course "Sensors and Measurement Technology" for electronic information students (college upgrade) as a compulsory course. The syllabus requires a total of 48 hours, including 16 hours for theory and 32 hours for experiments. The main content of the course includes the basic knowledge of measurement and various types of sensors commonly used in current production and daily lives. From the perspective of class time , the theoretical hours are less, and students need to complete a large number of experiments to understand and mastery of important knowledge . To make sure the students integrate relevant knowledge in the limited academic , teachers' sorting and integration of teaching content is particularly important. This article starts from the cause of the course reforming and explains the ideas and design in the process of completing the course reforming. Assessment, feedback and reflection are aimed at instilling the teaching work of the entire course with the concept of subject integration, so as to achieve a comprehensive improvement of students' professional abilities.

1. The cause of course reforming

1.1 Course characteristics analysis

The sensors in the textbooks selected for this course are generally classified according to the type of measurement, and the previous lectures are also completed according to this idea. The composition of the sensor mainly includes sensitive components, conversion components and conversion circuits. Since the sensitive components involve many subjects such as physics, materials science, chemistry, and biology, students feel both boring and difficult to understand in their studies; the conversion circuit of the sensor involves the knowledge of analog electronics and digital electronics, and some are even related to high - frequency electronic circuits. It can be seen that how strong the comprehensiveness of it can be. This requires our teachers to find suitable entry points in the theoretical and practical teaching process to strengthen the application and improve the cognition of students.

1.2 Academic analysis

Some of the students who have entered the college level are relatively weak at the basic study, and feel that it is difficult for them to understand in the teaching, which leads to a gradual loss of interest in learning. The traditional sensor experiment course mainly focuses on studying the relationship between the physical quantity and electricity of various types of sensors, as well as its basic dynamic and static characteristics. As it only involves the structure and principle of the sensor, students still cannot use it after completing the experiment. Apply what you have learned from the perspective of the system.

Undergraduate students from the major of Applied Science and Technology Electronic Information are co-classes. There are as many as 88 students in the two classes this semester.If it is still the teacher's one-word lecture mode, it is bound to fail to achieve the good effect. Since the subject content is relatively boring and difficult to understand, it is difficult to attract students' attention. Therefore, the reform of the teaching mode and program is imperative.

1.3 The disadvantage of traditional teaching patterns

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In the past, the content of the course was mainly to explain the detection principles of various sensors. The students would feel boring and difficult to understand. After the course, they would not gain much. In the follow up courses and the graduation design, students will still seem to be unable to apply their knowledge about the sensors. In addition, students' participation in the teaching model original is not as high as the expect, and it is based in the form of one-talking teachers. Students have no motivation to learn and form inertia to study.To change this case,our methods are needed to reform. In addition, the content of the courses of experiment is outdated. The textbooks involve few new sensors, and the subject is not studied from the perspective of control systems.

Currently, the study of sensors is an indispensable and important part in the field of science and technology. On the basis of traditional conventional sensors, sensors with new functions such as miniaturization, integration, and intelligence have been continuously introduced. Sensor-related smart homes, The Internet of Things systems such as smart agriculture are gradually becoming mature. The continuous development of technology requires us to integrate and supplement this course.On the one hand, students are the main body for teaching work, and on the other hand, it is necessary to innovate and give students cutting edge scientific and technological guidance.

2. Teaching Reform Ideas for the Curriculum

Analyzing the current situation of similar courses based on OBE reforms, some higher vocational colleges have adopted result-oriented teaching methods, re-planning the courses, and project-driven teaching, but most of the project content is limited to the selection and configuration of the sensor itself, signal conversion, etc. It does not involve multiple related disciplines such as single-chip control and clouds configuration, so the content appears to be single, and the perspective of overall system is insufficient. Even though,most colleges and universities still adopt the teaching mode traditional . Our project team intends to adopt the OBE teaching model, designing multiple projects to drive teaching by completing different tasks in the project. By designing the project content reasonably, students have an overview of the system and study the sensor as an important part of it. They will learn how to construct a closed-loop system. After obtaining the sensor's information, it can be displayed by a computer, cloud configuration, mobile phone control and other solutions. In the implementation of the program, students need to combine the professional knowledge of multiple disciplines, and even need to supplement related knowledge such as communication protocols by themselves. It fully embodies the concepts of current scientific research that is blended between disciplines, which is of great benefit to broaden students' knowledge system and improve application ability.

3. The design of the teaching reform program

The teaching reform is implemented from two aspects: theoretical teaching and experimental teaching. Theory teaching makes full use of the OBE concept and task-driven to complete the teaching process, improving students' overall view and engineering perspective; designing new experiments in experimental teaching and making full use of existing platforms, due to the knowledge of involvement of ZigBee data collection, networking, and the single-chip control has greatly broadened students' application capabilities. The design of some typical cases, such as smart homes, smart farms, etc., helps students develop ideas and get exposure to the use of single-chip computers and the corresponding software, fully realized the integration of disciplines.

In line with the design ideas from simple to deep and comprehensive, the content of experiment is designed into three projects, forming a progressive model and introducing knowledge points from multiple disciplines in an all-round way.

Program 1: The temperature measure system based on Pt100

According to the signal characteristics of the sensor, it can be divided into several categories, such as the resistance type, the voltage type, etc. The subsequent circuits for different output signals are completely different, and the same signal can have the same circuit structure. Only need to modify the parameters in the circuit to achieve the purpose of amplification or conversion. This project uses Pt100 as the sensor, converts the signal detected temperature into resistance value, uses analog circuit knowledge to convert the resistance value into voltage, then sends it to the microcontroller system for display. The specific implementation block diagram is shown in Figure 1.

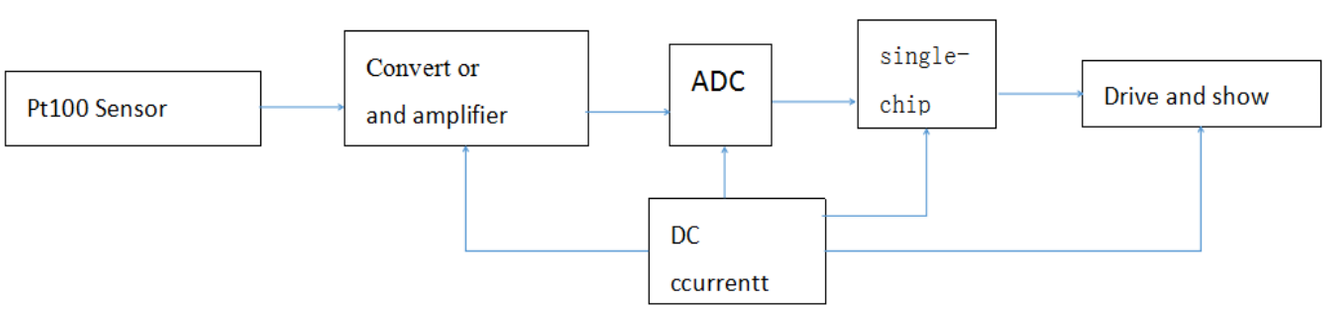

Figure 1 the block diagram of Pt100 measure system

Each sub-circuit designed in this project contains other basic or professional courses of this major. If the conversion and amplifying circuit uses an integrated operational amplifier, it involves the knowledge points of the circuit and analog electronic technology. It is necessary to configure each parameter reasonably to achieve an effective voltage output. The circuit of this part is shown in Figure 2. The circuit design uses Pt100 as the feedback of the operational amplifier of the same phase, which can affect its magnification, and then change the output value, send the signal to the voltage comparison circuit and the subsequent amplifying circuit to achieve the change from resistance value to voltage value. Pt100 can obtain the resistance value corresponding to different temperature points by consulting in the index table between 0-100℃, and then obtain the voltage output under different resistance values by analyzing the

circuit.

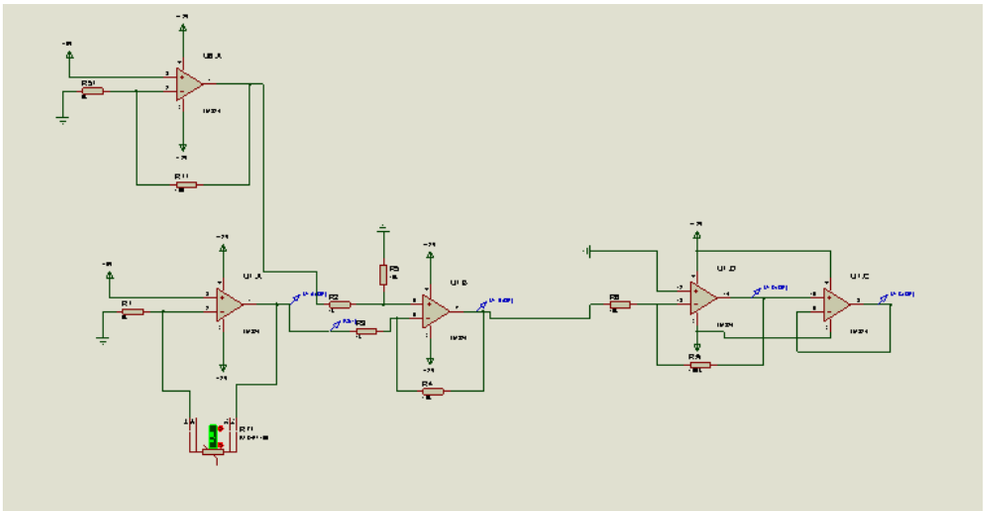

Figure 2 the simulation diagram of convertor and amplifier

It can be seen that through in-depth study of the circuit, students have a very perceptual understanding of the subsequent conversion circuit of resistance sensors, and they can apply the knowledge points of circuits and operational amplifiers they have learned before.

The voltage signal obtained by conversion and amplification can be displayed in a variety of ways. In this project, it is recommended that students use single-chip microcomputer control, which can realize digital display and facilitate the improvement of accuracy. ADC0804 is ADC that converts the the voltage signal into a digital quantity and sent to the single-chip microcomputer. The single-chip microcomputer can digitally display the temperature value detected by the current Pt100 through programming. In practice, it is found that the single-chip micro-computer can achieve a better output by driving the digital tube through the 74LS245. It can be seen that the realization of this part of the circuit requires the flexible use of digital circuits, analog circuits, and the knowledge of the principles and circuits of single-chip microcomputers. It is a comprehensive application and the overall improvement of the knowledge learned by students.

This project is typical. It is aimed at the circuit design of Pt100 thermal resistance, students can draw inference about it, and have a good reference for resistive sensors, while voltage sensors can directly use the circuit to achieve conversion and display. In the implementation of the project, students are required to design the circuit in blocks first, then calculate the data and perform simulation. From simulation to physical objects, and breaks the barriers of disciplines. The comprehensiveness is very strong. During the implementation of the project, students can establish a concept of certain engineering , which not only strengthens the circuit and electronics and the application of the single-chip microcomputer, at the same time help students to consider the problem from a systematic and comprehensive perspective, not just limited to the stage of understanding nature and perceptual knowledge of the sensor.

Project 2: Data acquisition experimental module based on ZigBee

The project adopts the form of a test box and works in the ZigBee data collection mode. The main module has a standard sensor interface. Students can use sensors to realize data collection on the ZigBee module and build a wireless sensor network. The sensor modules that can be matched include ultrasonic, combustible gas sensors, sound sensors, temperature and humidity sensors, and many other types. The project uses the existing circuit modules to complete the hardware connection through selection and overlap. The core work lies in the establishment of the network and the realization of communication. Through this project, the concept of engineering is further established, and the learning and grasping of the whole system is improved.

The main body of the experiment box is a pocket machine. The blue expansion board is connected to the pocket machine to receive the data collected by the sensor. After the red bottom board is connected to the sensor module, the collected data can be sent. The transmission of information uses ZigBee technology.

Through this project, students focus on mastering ZigBee communication technology from protocol to software, familiar with the technical points from point-to-point to multi-point detection. So that after this class our students can be familiar with the network construction process and the latest technology applications.

Project 3: Internet of things system based on the sand table

Two sets of sand tables are conceived, one is a smart agriculture system that imitates real scenes, and the other is a smart life sand table that integrates transportation and home.After the micro-scene layout is completed, multiple types of sensors are placed in suitable locations to complete real-time detection of multiple data. Data communication can be achieved through multiple methods such as Bluetooth or WiFi, and can be monitored and controlled on a mobile phone or panel.

Take the smart agricultural sand table as an example. Various sensors such as light, smoke, air temperature and humidity, Doppler, carbon dioxide detection, soil temperature and humidity, PH value, the direction of wind and wind speed are arranged in the sand table. Most of the sensors are wireless type, and the detected signals are sent to the link of central control through the wireless communication module. Because of the large number of control points, the embedded hardware system is adopted. The output is sent to 8 relays to control the on and off of various electrical appliances to achieve a comprehensive system of control about intelligent

agricultural . For example, the signal of lighting is measured by the light sensor, and compared with the preset limit to control the opening and closing of the top sunshade; the Doppler sensor is used to monitor the entry of people, and there can be prompts or warnings; the measured value of air temperature and humidity is compared with the setting value, then it controls the on and off of the humidifier or the fan; and the soil temperature and humidity detection module is used to control the irrigation module.

During the exercise, students can identify the sensors in the entire system, receive communication signals through mobile phones or panels, disassemble each perception module in the learning system, change the upper and lower limits of the preset values to analyze the dynamic output of the system. During this process, the system is comprehensive to be learnt as a wireless sensor technology. The design of the project makes students fully aware of the importance of sensors in their lives. It is a technology within reach. Mastering it can improve the quality of life, reduce personnel investment, etc. So that, students can see the future and hope of technological development, and stimulate their learning motivation, clear their learning goals.

4. Implement the teaching plan based on the OBE conception

It is important to explore the conception of OBE and use the project to drive the teaching content. After the teaching task is given, the student will give a feasibility plan by consulting the data, and then analyze the advantages and disadvantages of the plan after selecting the model. During this process, students can learn various types of sensor and the functional characteristics of it. Since it is based on the problem, the students can be more effectively familiar with the application of the sensor, so that the teaching of the principle of the sensor is transformed into an understanding of its function and application. At the same time, by making full use of flipped classrooms,we can give full play to students' subjective initiative, and complete the tasks in groups, which greatly increases student participation and achieves a student-oriented teaching model.

The assessment mode discarded the original flat-volume assessment mode, and replaced it with a comprehensive assessment. The assessment needs to adapt to the changes in teaching methods. Individual scores are a combination of group scores and individual contributions, and the scores obtained had better reflect the true level of the students. Process evaluation is the key point, and the scores cannot be determined by the scores on the rolls, but the comprehensive consideration of multiple links to obtain the students' final scores according to the weights. If the distribution of performance weights is used as a means to mobilize students' enthusiasm, students can get greater participation.

In the actual implementation of the teaching reform, the following points should be noted:

(1)Design teaching with the main purpose of the syllabus, then supply and perfect the syllabus during the process of actual teaching ;

(2)Make a teaching plan according to the number of course hours, and arrange a reasonable schedule with full consideration of the characteristics of the students;

(3)Design teaching tasks according to the teaching content, and put the OBE concept through the whole concept to the teaching to make sure the students are the main body;

(4)The designed sensor experiment that integrates between disciplines not only highlights the teaching task of the sensor, but also achieves the grasp of the entire system engineering to reach our target;

5. Summary

The sensor teaching reform implemented under the OBE concept-subject integration project teaching involves networking technology, new sensors, Internet of things and other new knowledge, which can better stimulate students' enthusiasm for learning and consolidate multiple subject through subject integration and get the latest knowledge of sensors. Since the implementation of this project, the students' feedback is that the classroom is more intense and rich, even after class they have to consult information, modify procedures, etc., but the process of gaining knowledge is joyful.

Since the teaching reform project has just been put into precise, there are still some problems in the selection of content and the grasp of the rhythm. It requires continuous accumulation of experience, perfecting each link, and finally presenting it in a more comprehensive and systematic manner. In addition, during the implementation, the project team members are required to have knowledge reserves of multiple disciplines, give play to their strengths, learn from each other, design and improve each sensor project, try to employ more cutting edge sensor technology, and ensure the reliability of project implementation.

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