Design of the Experiment Teaching Model of Multi-mode Integrated Hardware Development with Arduino

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Abstract. In terms of the hardware development training of applied talents in the field of Internet of Things, due to backward teaching methods and diverse motherboards and chips in experiment teaching, the experiment process is chaotic and practical development costs much time and energy. By introducing the experiment teaching architecture of multi-mode integrated hardware development with Arduino, the model of the common hardware development system is established, thusconstructing innovative heterogeneous hardware environment integrated teaching model and mixed embedded hardware development programming teaching model, integrating experimental development teaching motherboards and chips. This paper also puts forward the experiment teaching steps of multi-mode integrated hardware development with Arduino, thus providing useful reference for the hardware experiment teaching of such majors as Internet of things.

Keywords: Integration · hardware · Internet of Things · Experimental teaching

1 Introduction

The cultivation of applied talents is one of the important directions of higher education nowadays [1]. Such majors as Internet of Things and electronic technology lay particular emphasis on the cultivation of hardware development ability of applied talents. However, since hardware development courses have strong practical characteristics, the learning content is rather boring, and the operation of experimental components is not easy to master, the teaching effect is often not satisfactory. As an open source electronic development platform, Arduino is suitable for beginners to learn hardware development. At present, classroom teaching of Arduino in colleges and universities is mostly based on theory teaching and supplemented by experiment teaching, which mainly involves practical and verified experiments. However, in order to learn Arduino well, if students just blindly learn the theory without experimental exercises, it is difficult for them to thoroughly grasp the relevant knowledge of Arduino in a real sense. In addition, because the experimental development requires different chips, in different experiments, students need to switch experimental equipment, in the actual operation process, there are still a lot of problems and inconvenience, which seriously affects the results and efficiency of experimental operation.

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2 The Teaching Architecture of Arduino Multi-mode Integrated Hardware Development Experiment

2.1 Equipment Innovation for Integrated Experiment Teaching

Arduino has different types of motherboards and a variety of supporting sensor components. It is not only inconvenient for schools to purchase uniformly, but also cost much for students to purchase by themselves, making it inconvenient for them to purchase for after-class use. To solve this problem, multiple different types of chips such as 51 micro-controller, STM32 and Arduino can be integrated into one experimental box, so as to make new multi-mode integrated hardware development equipment for hardware development teaching. This can help students understand and compare the similarities and differences of various chips at the same time, and cultivate their programming ideas and ability of hardware debugging and processing in different development environments. The default programming environment of the device is mainly Arduino IDE, so that a complex experiment can be realized with simple codes without calling too many complex functions. This not only saves the time for basic experiments, but also allows users to spend a lot of time on experimental innovation.

2.2 The Framework of Experiment Teaching

The framework of experiment teaching: This framework is composed of three modules, namely experimental introduction, practical operation module, experimental expansion and summary. In the practical operation module, there are two small modules directly related to it: teacher's follow-up and practical operation guidance. Within each large module, there are also specific content in different smaller points. The elements are closely connected and interact with each other to form a stable structure of teaching activities. The detailed teaching framework. As shown in Fig. 1:

Introduction to the experiment: This module will contain principles, steps, and results of the experiment. Experimental education theories refer to the abstract generalization of experimental teaching phenomena or educational situations. But experimental theories essentially transcend concrete facts and experience. Although they are a narrative system in form, the experimental content illustrates educational facts and experience in a condensed form.

Practical operation module: The purpose of practical teaching is to guide students to participate in practical activities, combine practice and theory, so as to improve students' comprehensive quality, enhance their ability to grasp knowledge. The practical operation module includes experiment recommendation, practical operation, principle analysis and observation experiment. This can help students from small details to big whole, based on the knowledge to do a good practice plan, enrich the meaning of practical operation, so as to harvest good effect of practical teaching, and realize the real combination of theory and practice [2].

Experimental expansion and summary: Experimental summary is a summary that describes and records the purpose, reason, methods and results of the experiment, thus forming a written experiment through logical thinking. In this process, students can find the defects and deficiencies in the experiment, thus generating the desire and sense

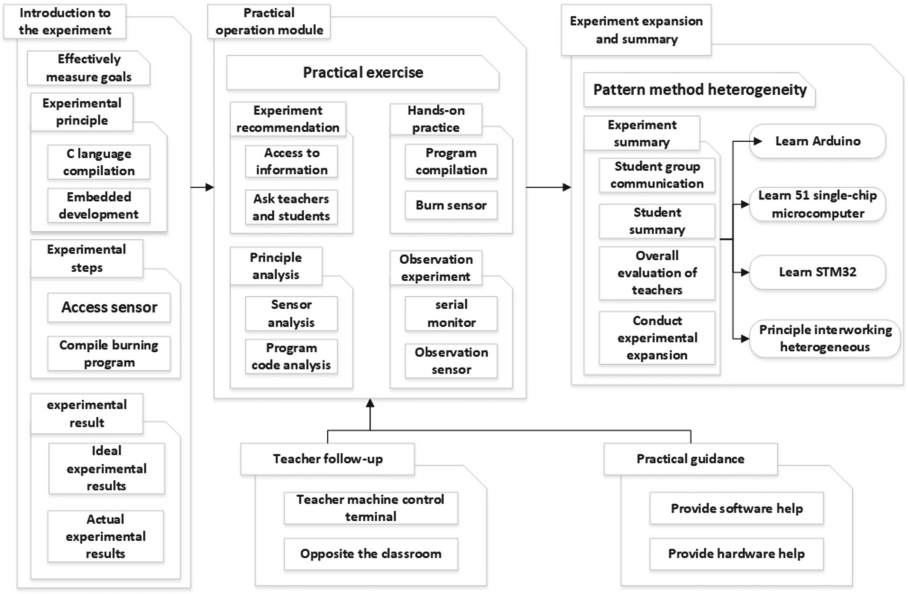

Fig. 1. The experiment teaching framework of multi-mode integrated hardware development with Arduino(Self-drawn)

of urgency to learn. This can urge students to strengthen the learning of theoretical knowledge and improve their ability of practical operation.

3 Construction of the Experiment Teaching Model for the Multi-mode Integrated Hardware Development with Arduino

3.1 The Establishment of the Common Knowledge Model for Multi-mode Integrated Hardware Development

In the teaching of 51 micro-controller, STM32 and Arduino, we aim to find the logical relationship between different knowledge systems, and establish the common knowledge model of multi-mode integrated hardware development. This approach integrates the common knowledge structure of general hardware development into a whole assembled according to a certain order and internal connections. This whole generates the overall advantage of knowledge structure and the heterogeneity of knowledge structure. The detailed common system model. As shown in Fig. 2:

Microcontroller, STM32 and Arduino have their own characteristics and functions. The Arduino multi-mode integrated hardware development unit makes use of their shared internals and circuit designs and integrates them, thus getting the best out of each chip and bringing together functions, which solves the defect of single experimental development and greatly improves the experiment efficiency. And they are all based on C language in programming. This can effectively avoid the exclusion between the chips, which can result in the failure of the experiment to be completed.

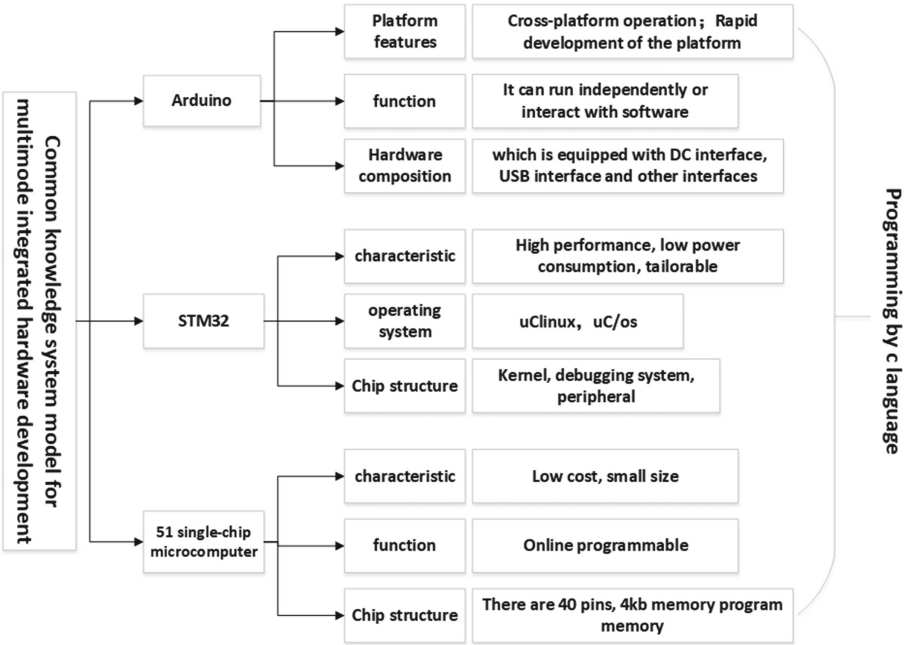

Fig. 2. The common knowledge model for multi-mode integrated hardware development (Self-drawn)

3.2 The Integrated Teaching Mode of Heterogeneous Hardware Environment

In the experiment, the universal common knowledge structures of hardware development are integrated into a whole according to a certain order and internal linkages.

Even different development chips have commonalities in their internal structures, such as their circuit structure, so we need to understand the internal structure and circuit of various motherboard chips for development. Teachers publish the guide sheet, knowledge points and time nodes of learning tasks for the structure and circuit of the development chips through online learning platforms. After completing the learning tasks in the guide sheet, students will have a simple understanding of the development chips. And in offline scenarios, teachers guide the students to delve into the internal structure and circuitry of the chips. This enables students to gain a deeper understanding of the various development boards and then summarize the same internal structures and circuits among them. This can help students understand more abstract concepts and deepen their cognition and understanding of the experiment.

The next step of experiment is to guide the students to make a summary, and lead the students to carry out the basic teaching exercises of this experiment, that is, the most basic circuit design and wiring exercises. Students will also be required to complete experiments on wiring between the various structures of the chips. In this process, students can get more familiar with the experimental equipment and grasp the experimental principles [3].

3.3 The Teaching Mode of Mixed Embedded Hardware Development Programming

The multi-mode integrated hardware development device with Arduino mainly writes programs in Arduino IDE compilation environment. The Arduino IDE compilation environment writes programs with C language as the development language. Moreover, the development chip on the experiment box is also designed with C language as the development language. It can thus be known that, in order to learn this experiment course well, students must first be proficient in and use C language for development and programming.

This course adopts the online and offline teaching mode. Teachers publish the relevant knowledge points of C language programming and the module exercises of corresponding knowledge points online. In the preview stage, students need to complete the corresponding knowledge points and exercises, and at the same time, they need to take notes of the important and difficult points met in the preview process. In offline scenes, teachers use the method of visual demonstration to explain and analyze the knowledge points for the students. In this process, students can raise their own questions [4]. After class, teachers assign programming assignments, which students are required to complete and submit online.

A lot of after-class exercises can improve students' programming ability and logical thinking ability, and provide a more solid foundation and guarantee for multi-mode integrated hardware experiment and practical operation with Arduino.

4 The Experiment Teaching and Implementation Steps of the Multi-mode Integrated Hardware Development with Arduino

In the experiment teaching of multi-mode integrated hardware development with Arduino, the experiment box connects and integrates three kinds of chips, namely the single chip microcomputer, STM32 and Arduino, into one piece through circuit design. Students need to have a certain foundation in each module. This requires experiment teaching in steps followed by the linkage of the modules. This can form an embedded system to achieve the ultimate goal of experiment teaching [5].

Step one: The first step is the study of experiment theories. It requires students to learn the common software development environment, drivers and shared hardware, of the device for the multi-mode integrated hardware development experiment. This will help students understand the integration principles of the Arduino multi-mode integration development device, specific experimental steps and problems to be paid attention to in the process of development experiments.

Step two: The Arduino multi-mode hardware development device is mainly used for experiment teaching in the Arduino IDE environment. 51 MCU, STM32 and Arduino development motherboard chips can all be programmed by Arduino IDE. The compilation language used in the Arduino IDE is C language. Therefore, learners need to have a certain level of C language programming ability. This requires to enter the mode of embedded development programming first, that is, to guide students to write and design programs required by the topic on the basis of C language, and run correctly and successfully.

Step three: The teacher will conduct a complete simulation run of the field experiment, draw a flow chart, write a program, and burn the program code into the experiment box for Arduino multi-mode integrated hardware development for the students to observe the experimental results. After that, the teacher will let the students try to apply the three-tier architecture pattern (the presentation layer, the business logic layer, data access layer) into real life. Before programming, students analyze the process of realizing hardware functions, draw a flow chart, divide levels and steps to write codes. Finally, students burn the program to the Arduino multi-mode hardware integration development device to achieve the status of data access.

Step four: In the extended design experiment, students summarize and master the knowledge they have learned in groups, and complete the assignment with their ideas. During the process, students can consult relevant materials, achieve their own expected results, and share experimental results and ideas with other groups in class.

The design of the whole experiment is with four steps, proceeding in an orderly way, with close links between the steps, and each step is indispensable. This enables students to better grasp and understand the principles of the experiment box for multi-mode integrated hardware development with experiment box, improve the learning efficiency of the experiment, and cultivate innovative and creative thinking [6]. Thus achieving the goal of the experiment design for multi-mode integrated hardware development with Arduino.

5 Conclusion

The Arduino multi-mode integrated development unit is a experiment box that integrates a variety of hardware development motherboards. It can help students to understand the internal structure and specific operating steps of various development motherboards more intuitively and conveniently, and it can cultivate students' logic ability to operate a set of learning theories in different development motherboard chip environments. It makes up for the shortcomings of the single and limited experiments of development motherboards [7]. The handout of experimental design of the multi-mode integrated hardware development device with Arduino facilitates the students to carry out experiments of development motherboard chips, so as to help them to more clearly understand the purpose, principle and steps of the experiment. The entire experiment design includes the specific process and framework. According to the design of experiment steps, students can clearly understand the idea of the experiment, consolidate theoretical knowledge, Achieve teaching objectives.

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