Web-Based Online Testing System for Multi-core Computing Curriculum

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Abstract—Multi-core technology has been the mainstream in microprocessor design to solve the problems concerning the thermal, power and performances of processor chips. It has brought new concepts and changes in computer architecture. This is also a tremendous challenge to the education in computer science. How to teach multi-core technology to the students is one of the main concerns of the universities. In this paper, a web-based online testing system designed for the multi-core computing curriculum of Zhejiang University is described. This system is opened to all the students in our curriculum to help them study multi-core technology more efficiently.

Keywords—Web-based system, online testing system, multi-core computing, curriculum.

I. INTRODUCTION

THERMAL, power and performance has been the bottleneck in microprocessor design in recent years when only a single processor core is integrated into the chip [1 - 2]. Multi-core technology [3] seems to be the most potential solution to these problems. After multi-core has been proposed, it becomes the mainstream in microprocessor architecture. Many changes are derived from the new concept in computer organization, computer architecture, operating system, programming model and languages, and some other fields of computer science. Researchers have proposed their own design and described different implementation for multi-core such as [4 - 8]. And many leading companies also have designed and produced the commercial multi-core processors such as Intel Core 2 Duo processor [9], SPARC architecture [10], IBM CELL [11], ARM [12].

Multi-core has also brought challenges to the education in computer science of the universities. Many curricula have to be re-designed according to the relative enormous changes brought by multi-core technology. Different universities have adopted different approaches in terms of features of the individual curriculum. There are two main approaches and they have their advantages and disadvantages. Some universities have taken the knowledge of multi-core technology as the supplement of the existing curricula such as MIT [13], Trinity College Dublin [14] and Hong Kong University of Science and Technology [15]. The main problem of this approach is that the different knowledge points of multi-core technology will be taught to the students in the dispersive form and the students can not master the unitary architecture of the new technology. Some other universities have designed new curricula to teach multi-core knowledge according to their research background in this area such as Georgia Institute of Technology [16]. The main challenge is how to design a new multi-core curriculum.

Zhejiang University has adopted the latter approach [17]. A new curriculum titled “Multi-core Computing” has been designed as a special one for multi-core technology. When the curriculum is designed, a web-based Online Testing System (OTS) is also designed and implemented to the students. This system can be used by the students to test them online and evaluate their learning. In this paper this system is described in detail.

The rest of this paper is organized as follows. Section 2 describes the background of the OTS from the perspective of the whole multi-core curriculum of Zhejiang University. Section 3 describes the system architecture of OTS. Section 4 presents the experiences in construction of OTS. And in section 5, conclusions and future work is offered.

II. BACKGROUND: THE “MULTI-CORE COMPUTING” CURRICULUM

The processor cores integrated on a single chip will be increased rapidly with the continuous progress of semiconductor technology. The enormous changes brought by multi-core technology will impact computer education at universities. Zhejiang University has investigated on multi-core education at some other universities and then designed its own multi-core curriculum titled “multi-core computing” based on our research on multi-core technology simultaneously. two programs have been designed for undergraduates (undergraduate program) and graduates (graduate program) respectively. [17] has described the detail of these two programs. Almost all the knowledge points of multi-core technology have been covered by this curriculum as shown in Fig. 1. Multi-core curriculum has a knowledge point matrix including twenty multi-core technology related knowledge points. These teaching contents will be taught to undergraduates and graduates via the two different programs respectively. The undergraduate program focuses on multi-core programming training and the graduate program focuses on...
training the research ability of the graduates.

When this curriculum is constructed, what it concerns is not only the curriculum design itself of this curriculum but also the other important aspects on multi-core education including the teacher team construction, collaboration with industry, environment construction, teaching materials and the teaching experience sharing [18] as shown in Fig. 2.

There are six parts of the entire picture of the multi-core computing. Curriculum design is the core of the whole curriculum. The other five parts provide more teaching contents plentiful resources and efficient practice to construct the multi-core computing curriculum. These five parts are also taken into account. They will be organized as a whole architecture of curriculum construction.

During the teaching, it found that the students need a reliable approach to examine the results of their study to help them master the theory better. What they need is not a complex system providing complex functions but a convenient platform to test them anytime and anywhere. Then an online testing system is designed and implemented as the additional materials to our curriculum. This system mainly focuses on multi-core theory according to our simple principle. Programming techniques will be practiced by some other approaches [18].

The online testing system is opened to the students as the curriculum resource after class. It also helps the teachers to find the main problems of the students’ study and provide instant solutions.

### III. System Design and Implementation

The target of OTS is to provide a platform to the students for testing themselves online. The whole architecture of the OTS is shown in Figure 3. The system architecture of OTS consists of three parts: Test Item Database (TID), OTS User Component (OTSUC) and OTS Administrator Component (OTSAC). TID is the core of OTS. TID, OTSUC and OTSAC will reside on OTS Server (OTSS) to provide the service to the students.

In all knowledge points of multi-core curriculum as shown in Fig. 1, there is much theoretical knowledge and it is the basis of the programming training and the advanced research training. So the theoretical knowledge is the main contents of TID. The contents of TID are also organized according to the knowledge point matrix shown in Fig. 1.

OTSAC is provided for the administrators of this system. The following is the functions of this part:
- The interface for the administrators to add, delete and modify the test items;
- The interface for the administrators to browser the grades of the users’ tests;
- The interface for the administrators to analyze the test item difficulty.

OTSUC is provided for the common users. The following is the functions of this part:
- Online testing for the users;
- Random test item select from TID for undergraduates.

![Fig. 1 Multi-core curriculum matrix](image1)

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![Fig. 2 Curriculum construction](image2)

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![Fig. 3 The system architecture of OTS](image3)
and graduates respectively with different difficulty;

- To record the frequency and accuracy of the different items;
- To record the frequency and accuracy of the different users;
- To show the grades of the tests and the results of the items to the users instantly after the online testing.

IV. EXPERIENCE IN OTS

A. Cooperation with the whole curriculum construction

The objective of this curriculum is to teach multi-core technology to the students. And the construction of multi-core computing curriculum is designed as a systemic project. So each part should cooperate with each other to achieve the objective. OTS is also designed to work as a part of the whole curriculum construction from the beginning.

In our design, OTS will cooperate with experimental platform, online programming and online forum to provide different service to the students. They are developed as the whole environment of this curriculum. The relationship among these different platforms is shown in Fig. 4.

The four platforms are organized as a mesh with four nodes. Each node has the interconnection with each other. It means that if the students have made any progress in any node, it can promote the common progress of the others.

The four platforms have close relationship. The interconnections among them will give positive feedbacks. For example, if there are any questions when the students use the online forum platform, they can publish these questions in online forum. After they get help from online forum, they will be more skillful when programming on online programming platform. When the students have more experience on online programming platform, they can provide more help in online forum. It will help the others to progress. Thus when the students use the four platforms together, they will master multi-core technology more deeply.

B. Web-based design

The administrators will need to manage OTS at any time and any places and the students also have the requirements to test themselves anytime and anywhere. So OTS is designed to be used by the administrators and the students in different physical places. Web helps to achieve this objective.

OTS is designed and implemented based on web technology. The users including the administrators and the students will use OTS by web browsers. And the data processing will be done on the web server. OTS is placed as a part of the multi-core curriculum portal [19]. Fig. 5 shows the web presentations of OTS.

![Fig. 5 The web presentations of OTS: test paper information and the test paper](Image)

C. Concentration on TID

TID is the most important part of OTS. The key problem of OTS is to construct a good database. When the curriculum is constructed, it has focus on the teaching materials, teaching experience sharing and collaboration with industry. At the same time, it has established a multi-core laboratory for research on multi-core technology. So there are three different sources to get enough resources for test item database from these aspects. The main materials are textbooks, research documents, some open industry documents and the documents from some leading companies as shown in Fig. 6.

![Fig. 6 TID has three sources and four types of resources.](Image)

It needs many test items to construct TID and at the same time, the quality of the test items should be also assured. In our construction, a TID Generation Flow (TIDGF) has been designed to achieve this objective as shown in Fig. 7.

Two groups are organized for the item generation and the quality assurance respectively: TID Item Group (TIDIG) and TID Validation Group (TIDVG). The members of TIDIG are teachers in the teaching group of this curriculum. The TID resources will first be sent to TIDIG. These resources will be selected, sorted by TIDIG and then test items will be generated from these resources by TIDIG. Then these original test items
will be sent to TIDVG. The members of TIDVG are several teachers and some students. They will check these submitted items and bring forward their questions on them. If there are any questions, the feedback will be sent to the TIDIG and TIDIG will answer these questions or revise these items. The items passed the TIDVG will be published to TID. And if some questions are found during online testing, the feedback will be sent to the TIDIG to deal instantly. There are more than 2000 items in TID up-to-now.

Fig. 7 TID has two groups to assure the quality and quantity of the test items.

TID has two different levels as shown in Fig. 8. The first level (TID level 0) is designed for the undergraduate program and the other (TID level 1) is for graduate program. Each level has twelve sub-sections according the knowledge point matrix shown in Fig. 1. These two programs have different targets. So these two levels are also different.

Fig. 8 TID levels

Two levels are designed in TID for undergraduate program and graduate program respectively. Level 0 will cover the undergraduate knowledge points shown in Fig. 1 and Level 1 will cover the graduate knowledge points. The information of the students will be read from the system. When OTSUC generates test papers for the students, it will select test items from the different levels and sub-sections according to the grade of the students and the requirements from the students automatically. So the students can have unit quiz or comprehensive tests according to their learning status.

V. CONCLUSIONS AND FUTURE WORK

Multi-core technology has made the education in computer science of universities face new challenges. Zhejiang University has designed a new curriculum titled “multi-core computing” for multi-core technology. In this paper, a web-based online testing system (OTS) is described. This system is designed to improve the teaching effects of the multi-core computing curriculum of Zhejiang University. The experience in construction on such a system is shared in this paper. With the progress of multi-core technology, the curriculum still needs to be improved. In the future, we will continue to improve OTS in the following aspects: to update the TID more immediate; to enhance the interaction between the teacher group and the students in OTS.

REFERENCES