Industry towards Embedded Curriculum Development

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Abstract - Embedded system technology is a fast developing discipline in recent years. Universities are challenged with how to catch up with the industry speed and how to combine the industry technology with the university education. In this paper, we contribute our thinking and some practice work in the embedded curriculum development. By focusing on several platform and setup the strong cooperation with the industry, by adopting the marketed product in the lab, by accumulating the contribution from both the teacher and students year by year, the limit university education resource is collect together to make the curriculum better, the curriculum is highly evaluated by the student, university and industry.

Keywords: Education, Embedded System

1 Introduction

As portable embedded devices and wireless communication are booming, they will have great impact on data and information services in the current human society and future world. These services would be data density, computation density, and communication density. Therefore, university education needs to improve itself to accommodate this changing. For Computer Engineering, Computer Science, Electronic Engineering department in all over the world, embedded system curriculum plays an important role in the university mayor education as it can integrate many professional knowledge of their major together and give the students a system viewpoint for the future career life.

Embedded technology is mainly drove by the industry which introduces an important challenge to the university on how to build the curriculum towards the industry. In this paper, we will give our thinking and some practice work to solve this problem we faced.

2 Catch up with the latest chipset

With the quick development of the embedded technology, generation by generation advanced embedded chipset went to market for industry products, better and better. How to make the lab design catch up with the quick changing technology? How to training the students with the state-of-art platform? This is a great challenge for the teachers. We try to figure out the solution from the following three aspects.

2.1 Focus on some special platform

It is well known that there are thousands processors, software and solutions in the embedded system industry. Which one is the best for embedded education? It is a pity that no one can give a convincing answer. Actually, what the university should transfer to the student is the knowledge itself. For embedded system, the architecture, the power management, the bus, the real-time OS, the porting methodology, the debug method, etc. are the fundamental knowledge points for the students. We do not need to be distracted by many solutions, and just need to focus on one typical platform. It is enough for the education itself, and made us being more expert in the general knowledge and special platform. For example, our embedded system adopts the Intel embedded platform from year 2004, and we were familiar with the traditional EIA platform and the latest Atom based intelligent platform.

2.2 Setup the deep cooperation with Industry

As the embedded system technology is mainly drove by the industry, it is important for the university set up the strong and deep cooperation with the industry to get the detail information, resource from the industry and know the future direction of the industry. We join in the Intel university plan and act as the leading university in China, attend the Intel embedded education summit every year and many other workshops and seminars, join in the cooperation research projects and get the latest materials and hardware platforms frequently. And also at the same time, we sharing our contribution into the Intel university program, sharing our education slides with other universities in China. This cooperation greatly help us setup the world class embedded curriculum and training the best students for the world (1).

2.3 Update the curriculum materials every year

In order to catch up with the changing technology, we updating the curriculum resource every year, not only the lecture slides, but also the lab designs and lab platform itself. This updating comes from the industry, e.g. Intel, from the understanding and work of the teacher and teaching assistant, and also from the students who join in the curriculum. The teacher should work hard on the update task, otherwise he/she will find the courseware is not fit for the students of next year.
3 Adopt the marketed product

As far as we know, most of the embedded products are powered by Linux and other open source software. Under the GNU general public license, many manufacturers have release their implementation based on the open source, such as some network router, web cameras, etc. These marketed products also are good lab platform for embedded curriculum.

We adopt TP-LINK MR3420 wireless router in our Lab which is developed by TP-LINK, one of the top network device manufacturers. This device use an Atheros SoC chip with MIPS core as its main embedded processor, and running embedded Linux to provide the network data transfer. As their Linux implementation has been released in the website of company[2], we contact with TP-LINK on adopting their product in the university education. They give the positive feedback and support us to try it with the GNU tool chain. Finally we successfully download the image into the device and it works. After that, we made more improvement for this lab design. Firstly, we refine the source code and build process to fit the university education, for example permanently destroy avoided bootloader design. Secondly, we compile a detail instruction book for the students from the fundamental information to the step by step operations. Thirdly, we further adopt the OpenWRT solution [3] for this MR3420 device to make the lab system more powerful and more open. Finally, we replace the on board 4MB Flash memory and 16MB SDRAM with large chips which make the students can design more complex function for the device.

As the price of each device is less than $30, the total cost of about 30 sets device does not exceed $2,000. These 30 sets MR3420 give over 150 students every year the opportunity to get experience on how to build Linux image for a ready-to-use product. Most of the students highly evaluated this lab design and interest in adding various functions for the device.

The advantages of adopting marketed products lie in,

1 ) Promote the interesting of the students, the students are glad to DIY an industry product by themselves, glad to make it works in the real world, glad to modify, customize and add the function in the product.

2 ) Hardware is durable for lab management, the industry products normally are more durable than the experiment box specially for the education. This feature let the burden and cost of the lab management is lower.

3 ) Low price, the low total cost makes it possible to purchase the devices easily and upgrade the lab platform using the next generation products in the future easily.

4 Incremental education

We believe the education should be accumulated year by year incrementally, neither keep it almost unchanged in several years, nor starting over every three to five years. According to the incremental construction, the curriculum resource for students and teacher will become better continuously.

In order to make the incremental construction possible, we firstly establish a curriculum framework which is fit for incremental improvement. From the viewpoint of a curriculum, the resource of it can be contributed from three aspects, teacher and teaching assistant, students who join in the curriculum, the industry sponsors. Therefore, the teaching resource, including the syllabus and the lab design, should be a long term developing plan. It can setup a prototype in the original first year, and has the potential to be enriched in the future decades. For example, real time is a key knowledge point in the embedded system, we give the fundamental theory of real time OS and the simple real time performance measurement lab in the first year of 2006. And then we refine the lecture slides and lab design in the following years, such as enhance and change the work load in the lab, add the new schedule algorithm in the system and measure the real time response time in the following years. All the excellent student labs were reserved in the curriculum FTP site and their lab reports and possible source codes were provide for the following years students. The new students were asked to learn from the previous work and do some difference. Then the incremental education works fine.

5 Curriculum Evaluation

With the efforts of years’ work, the courseware and labs update year by year according to the rapid progress of the embedded technology. As the course keep pace with the state-of-art technology, it is well reputed by the students. According to the statistic result of about over 1500 courses in Tsinghua University, the embedded system curriculum is the top 15% student favorite course of all. The embedded system experiment platform was awarded the first prize of best teaching software platform of Tsinghua University in 2008. And the course has been award the National Best Selected Curricula of Ministry of Education, China. In 2011, one of the lab work of the students win the 2nd place of Imagine Cup worldwide embedded competition.
6 Conclusions

In this paper, we proposed our work in deeply combine the embedded education with the quick developed industry technology. By summarizing the knowledge points of the embedded system, we believe the university do not need to diverse in many industry solutions, university can focus their efforts on one platform and keep the strong cooperation with the industry. The industry also can provides the low cost, interesting and durable to use devices for the lab experiment, they are good choices for the university embedded curriculum. Under the fast changing environment, the curriculum can build up their resource year by year with an incremental framework. Then the contributions from the teacher, teaching assistants, students can be combined together for the next year.

7 References

