History of Summer School on Embedded System Technologies Organized by Students and Young Engineers

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Midori SUGAYA (Dependable Embedded OS R&D Center)
History of SSEST committee

- **SSEST1**
  - held on August 2005
  - Midori SUGAYA (chair) and 9 members

- **SSEST2**
  - held on July 2006
  - Yutaka MATSUBARA (chair), Ittetsu TANIGUCHI (vice-chair), Hayato KANAI (finance chair), and 5 members

- **SSEST3**
  - held on August 2007
  - Shintaro HOSOAI (vice-chair), Takuya AZUMI (software manager), and 7 members

- **SSEST4**
  - held on September 2008
  - Me (chair), and 11 members
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• Introduction
  – background, motivation

• What’s SSEST?
  – objectives and contributions
  – history and organization of committee

• Learning contents
  – learning material
  – curriculum: prior training and boot camp

• Analysis of educational effect
  – satisfaction, usefulness, and experience point

• Conclusion
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Background

- A critical problem in Japan: Embedded system developers and researchers are not enough

- The abundant knowledge about both hardware and software is required for the embedded system technologies.
  - It is necessary to have
    - the wide perspective for the whole system
    - the capability to analyze and solve complex problems related to both hardware and software
    - the skill to manage team development project

- However, the learning time is limited in the information science or technology courses of undergraduate schools
  - Most students do not have sufficient time to learn and experience these things
  - Universities are places where one learns a little about a wide variety of things, including general education
Motivation

• Educational courses for embedded systems in Japan
  – NEXCESS (Nagoya Univ. EXtension Courses for Embedded Software Specialists)
  – QUBE (Q-shu(kyusyu) Univ. hardware/software Borderless system design Education program)

  **These courses have been provided mainly for industrial engineers**

• New courses in graduate schools started at following universities.
  – Tokai University, JAIST

  **However, these kinds of courses are still few**

New educational concepts are needed to provide useful opportunities for students and young engineers
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What’s SSEST project

- **Summer School on Embedded System Technologies**
- SSEST committee is organized by students in graduate schools and young engineers
- We have hosted summer schools for beginners from 2005 in each year
- SSEST provides opportunities to:
  - experiment of the whole development process
  - get the basic knowledge
- SWEST committee provides funds and advices about the learning contents to us.
Objectives and contributions

• Main target of SSEST participants are
  – graduate/undergraduate university students who are interested in the embedded systems
  – young engineers whose operations are the embedded system domain
  – beginners who aim to become experts on embedded system development

• The objectives of SSEST are
  – education for basic knowledge and skills
  – lively discussion among students and young engineers to improve each communication skill

• SSEST contributes to
  – provide a learning and experience opportunity to the beginners
  – educate committee members as the organizer of big project
History of SSEST

<table>
<thead>
<tr>
<th>Year</th>
<th>P: Participants</th>
<th>C: Committee members</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSEST1</td>
<td>Young Engineer</td>
<td>Doctor Course Student</td>
</tr>
<tr>
<td>SSEST2</td>
<td>Master Course Student</td>
<td>Undergraduate Student</td>
</tr>
<tr>
<td>SSEST3</td>
<td>Young Engineer</td>
<td>Doctor Course Student</td>
</tr>
<tr>
<td>SSEST4</td>
<td>Young Engineer</td>
<td>Doctor Course Student</td>
</tr>
</tbody>
</table>

P: Participants
C: Committee members
Organization of committee

- The members of the committee are from variety of universities that are in all parts of the country.
- Committee of SSEST is organized by approximately 10 members in each year.
- The member of committee is varied from year to year
  - totally, about 35 members (include 3 young engineers)
  - In most case, some participant of the last SSEST became the committee members.
Activity of committee (e.g. SSEST4)

- kickoff meeting
- website open (publication)
- prior training
- call for participation
- produce curriculum
- committee camp
- produce leaning material
- discuss concept
- boot camp
- review project & takeover

Nov. 2007

- Jan.
- Mar.
- May
- Jul.
- Sep.
- Oct. 2008
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Learning objectives

- Learning objectives are
  - Basic Knowledge
    - electronic engineering
    - computer architecture engineering
    - control engineering
  - Using system software and development tools
    - real-time OS, device driver, library, etc.
    - cross-compiler, linker, debugger, etc.
  - Programming for embedded software
    - assembler, C language, etc
  - Team development… Especially important!
    - communication with developers in different fields

We designed the original material and curriculum
The process for building our line trace car includes

- Making electronic circuits
- Building and using GNU development tools on cross development environment
- Design of motor control algorithm using microcomputer
- Assembling the body of the line trace car
- Embedded software development with C language
- Application development on a real-time OS
History of the material

- SSEST1/2
  - (simple) line trace car
- SSEST3
  - yabusame-line trace car
- SSEST4
  - color-line trace car
  - original base-board kit

✔ learning material has been developed for the better every year's committee
Why color-line trace car?

- The car can be assembled with inexpensive price and worked in a transparent manner
  - All the parts of our material can be bought at less than $100!
- The operating principle becomes multi-tasking
  1. running along a line on the course
  2. operating routine according to a color on the line
  - Each task is designed to perform under a real-time OS
Inside of color-line trace car

- **Hardware structure**
- **Software structure**
  - Control Application
  - Device drivers
    - sensors and actuators
  - Real-time OS: TOPPERS/JSP kernel
    - an open-source real-time kernel, and conformity with the uITRON4.0 specification.
Learning curriculum

- Prior training
  - Individual activity: about 1 month before boot camp
  - Each participant of SSEST make up the line trace car

- Boot camp
  - Collective activity: three days camp
  - All participants (and committee members) gather in summer school site
  - Main activity: experience the team development process
Prior training

• Mission
  – make up own line trace car for the boot camp
  – learn the basic knowledge about the embedded and real-time systems
  – get the basic skill of embedded development

• Educational support from committee
  – procedure manuals and references in website
  – mailing list for answer and share their questions
Contents of prior training

Part 1: practice of making circuits
   basic usage of microcomputer

Part 2: programming with real-time OS

Part 3: make up the line trace car
   program device driver & application

Step-by-step contents make easier to understand the basic knowledge

http://www.ertl.jp/SSEST/top/
Boot camp

- Collective activity for three days camp
- Boot camp includes
  - Lectures / Tutorials /
  - Team development /
  - Debrief session / Race

<table>
<thead>
<tr>
<th>Time</th>
<th>1st day</th>
<th>2nd day</th>
<th>3rd day</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td></td>
<td>Practical training</td>
<td>Practical training</td>
</tr>
<tr>
<td>10:00</td>
<td></td>
<td>Designing</td>
<td>Coding, Testing</td>
</tr>
<tr>
<td>11:00</td>
<td></td>
<td>Documentation of specifications</td>
<td>Preparation for the presentation</td>
</tr>
<tr>
<td>12:00</td>
<td>Reception, Opening</td>
<td>Lunch</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:00</td>
<td>Lecture 1: “What’s Embedded and Real-</td>
<td>Practical training</td>
<td>Preparation for the debrief session</td>
</tr>
<tr>
<td>14:00</td>
<td>Time System Development”</td>
<td>Designing</td>
<td></td>
</tr>
<tr>
<td>15:00</td>
<td>Lecture 2: “How to Write Requirement</td>
<td>Documentation of specifications</td>
<td></td>
</tr>
<tr>
<td>16:00</td>
<td>Specifications”</td>
<td>Coding</td>
<td></td>
</tr>
<tr>
<td>17:00</td>
<td>Tutorial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19:00</td>
<td>Dinner, Fellowship banquet</td>
<td>Dinner</td>
<td>Race</td>
</tr>
<tr>
<td>20:00</td>
<td></td>
<td>Practical training</td>
<td></td>
</tr>
<tr>
<td>21:00</td>
<td>Practical training</td>
<td>Coding</td>
<td></td>
</tr>
<tr>
<td>22:00</td>
<td>Check of development environment</td>
<td></td>
<td>Closing</td>
</tr>
</tbody>
</table>
Lectures & Tutorials

• Lectures by embedded system experts
  – “What's Embedded and Real-Time System Development”
    ▶ by a researcher in an university
  – “How to Write Requirement Specifications”
    ▶ by an embedded system developer

• Tutorials by committee members
  – the procedure of practice
  – the hint for project management
    ▶ role assignment (project manager, software developer, etc.)
    ▶ effective review & meeting manner
  – the hint for system development
Team development

• Main activity of SSEST
  – four or five participants make up a team
    ➢ communication skill of participant can be encourage to improve
  – design and implement a control programs of the line trace car
    ➢ experience a series of an embedded system development process, e.g. waterfall, spiral model

• Missions
  – To develop a line trace car as fast as possible at the race
  – To write system documentations
    ➢ Requirement specification
    ➢ Software design specification
    ➢ Software test specification
Debrief session

- Each team presents the achievement of boot camp
  - control algorithms of their line trace car
  - summary of documentations
  - how to manage team development
- Some embedded system experts are invited as guests
- The participants and guests discuss the achievement on team developments.
Race

- The modified line trace cars of all teams contest driving time on the race course
  - Although it is not true objective to be winner in this race, the race is very effective to improve motivation of participants
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Analysis of educational effect

- We had sent out questionnaires from participants
  - for reviewing and improving our activity
  - total number of answers: 100

- Analysis items
  - Satisfaction
  - Usefulness of learning contents
  - Achievement of objectives
Satisfaction & usefulness

• Degree of satisfaction
  – 94% of participants were satisfied.

• Usefulness of the learning contents
  – 97% of participants answered “very useful” or “useful” for their researches and works.
## Achievement of objectives

<table>
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<th>Objectives</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience of embedded system development</td>
<td>We could have provided an educational program that is stressed experience development process.</td>
</tr>
<tr>
<td>Comprehension of embedded system development</td>
<td>We could have provided plenty of learning contents for prior training. An opportunity can be acquired the advanced knowledge in several fields.</td>
</tr>
<tr>
<td>Acquisition of basic development skills</td>
<td>Providing the prior training and lectures, basic skills and knowledge can be acquired. Objective evaluation framework has to be introduced.</td>
</tr>
<tr>
<td>Team development and project management through group work</td>
<td>More than 50% participants were interested in team development and communication.</td>
</tr>
</tbody>
</table>

We could conclude this project got high appraisal.
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Conclusions

- SSEST: Summer School on Embedded System Technologies
- Main features
  - The project is organized by students and young engineers
  - The original education material and the curriculum.
- Contributions
  - To provide learning and experience opportunity to beginners
  - To educate committee members as organizers
- Original learning contents
  - material: line trace car
  - curriculum: prior training and boot camp
- Result of evaluation indicated SSEST was an extremely valuable opportunity for the participants
Challenges and future topics

• Challenges
  – Review and improve the learning material / curriculums
    ➢ opportunities to review them may be needed especially by experts
  – Objective evaluation of educational effect on SSEST
    ➢ participants’ / committee members’ growth

• Future topics
  – SSEST5 have already held on August 2009
    ➢ The results of SSEST5 will be reported sometime soon
  – We will continue SSEST and contribute to educational activities for embedded system technologies (SSEST6 ??)
Thank you for your attention!!