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

Table of contents

- 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

Table of contents

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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 thing
  - Universities are places where one learns a little about a wide variety of things, including general education

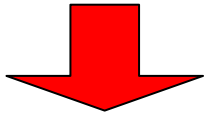
Motivation

- 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

Table of contents

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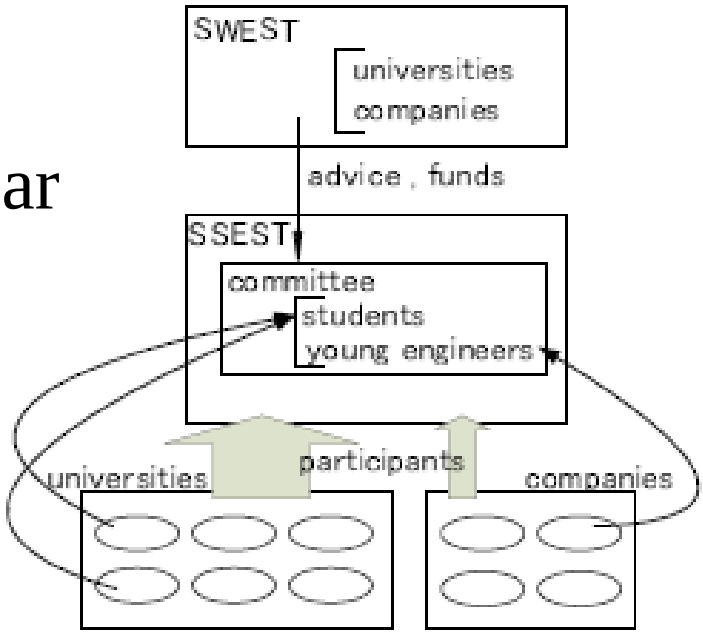
What's SSEST project

- **S**ummer **S**chool on **E**mbedded **S**ystem **T**echnologies
- 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.

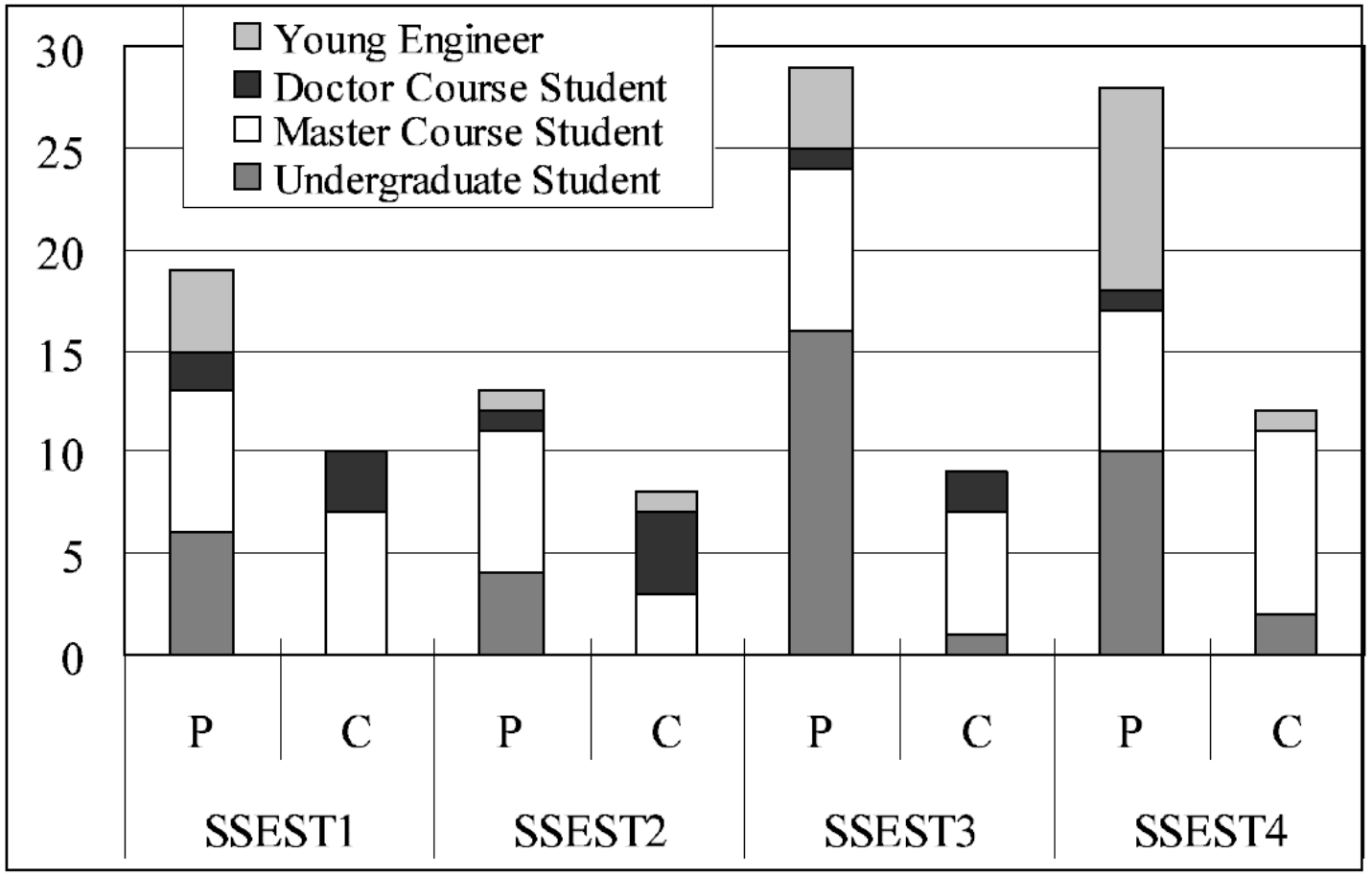


Objectives and contributions

- 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**

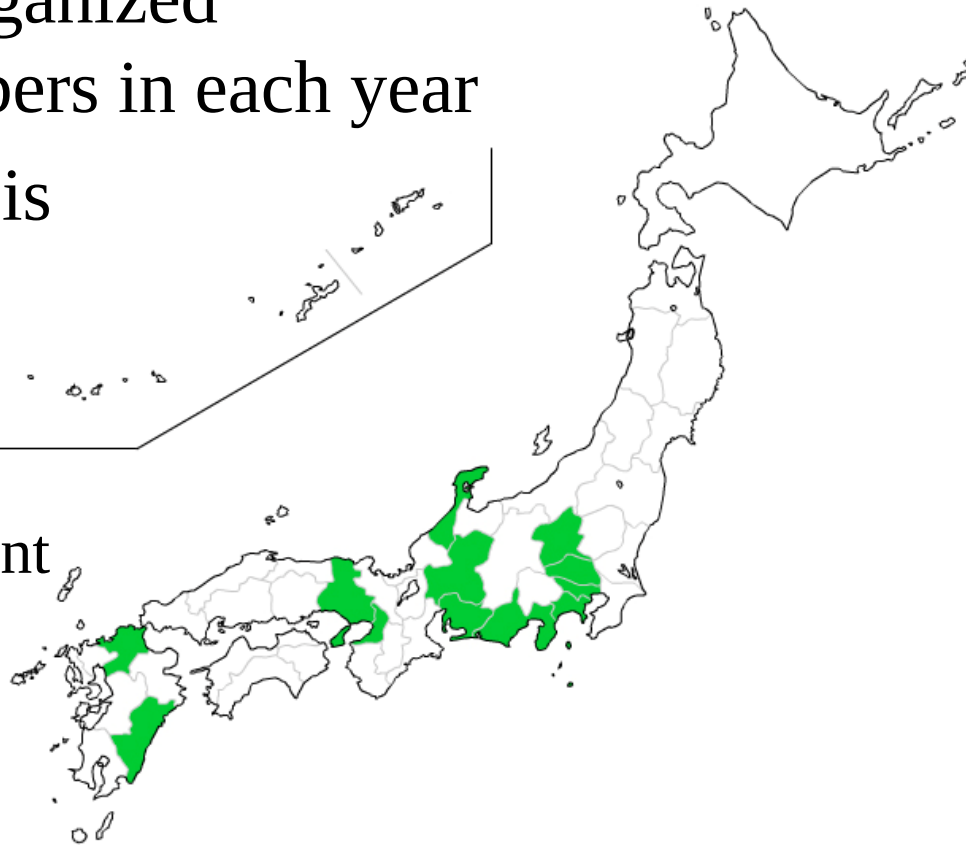
History of SSEST



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)

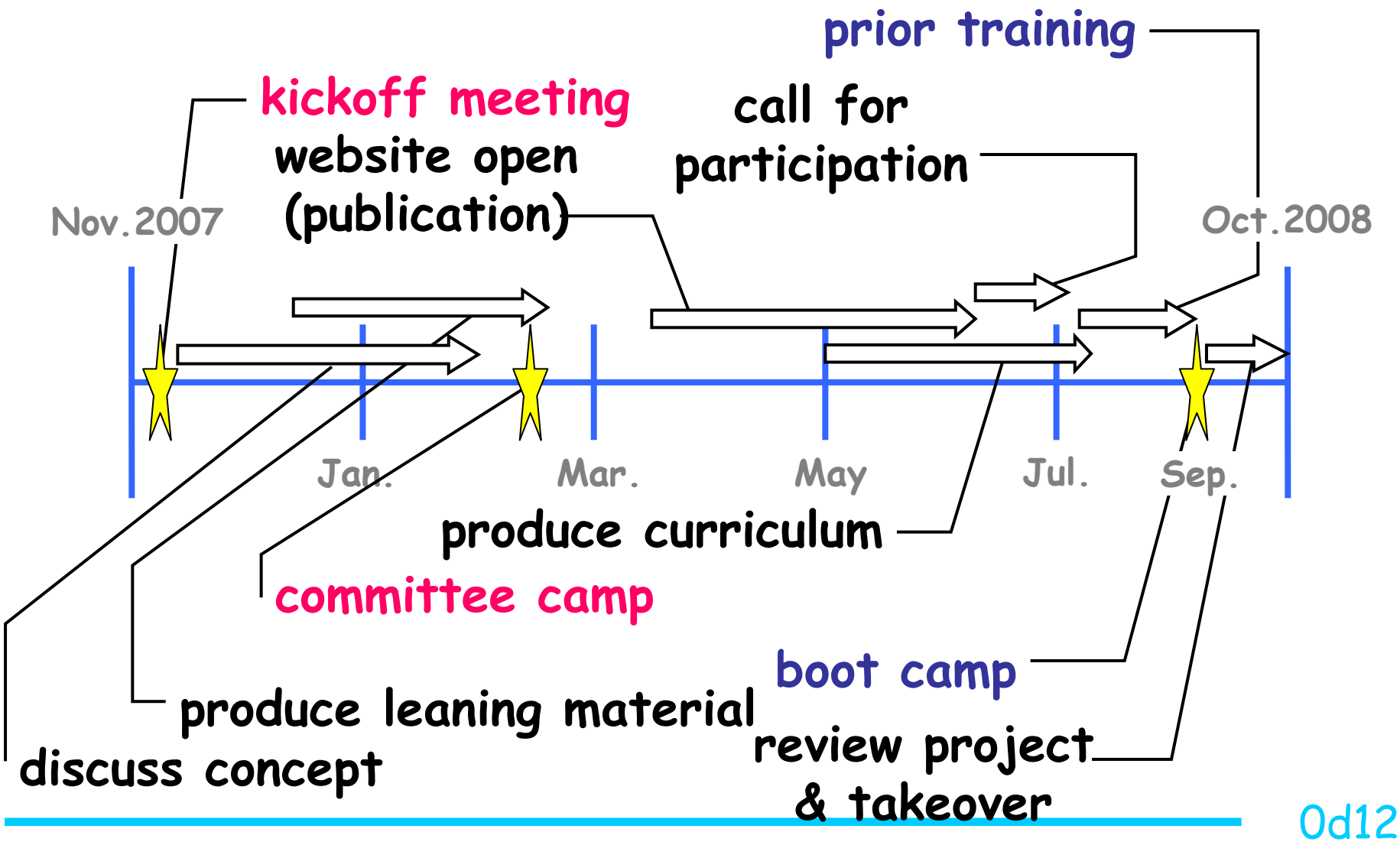


Table of contents

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Learning objectives

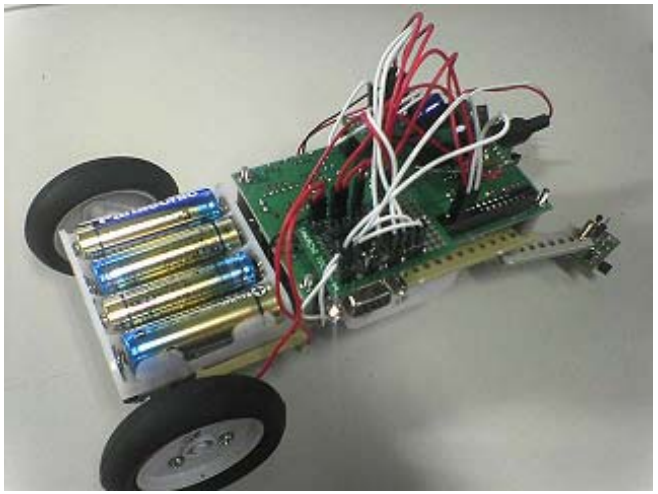
- Learning objectives are
  - Basic Knowledge
    - electronic engineering
    - computer architecture engineering
    - control engineering
  - Using system software and development tools
    - real-time OS, device driver, library, etc.
    - cross-compiler, linker, debugger, etc.
  - Programming for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

➡ **We designed the original material and curriculum**

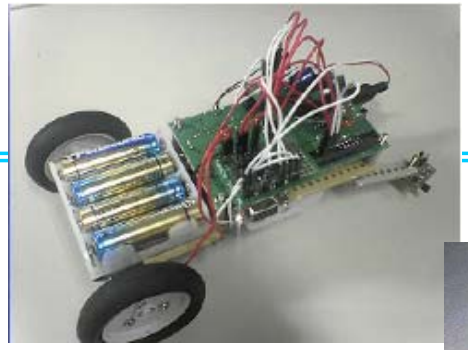
Summer School on Embedded System Technologies
SSEST
Since 2005

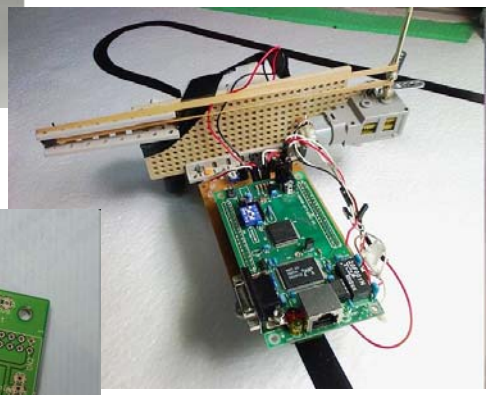
Learning material: line trace car

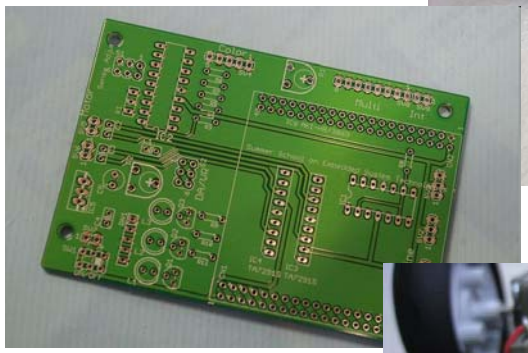
- The process for building our line trace car includes
  - Making electronic circuits
  - Building and using GNU development tools on cross development environment
  - Design of motor control algorithm using microcomputer
  - Assembling the body of the line trace car
  - Embedded software development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

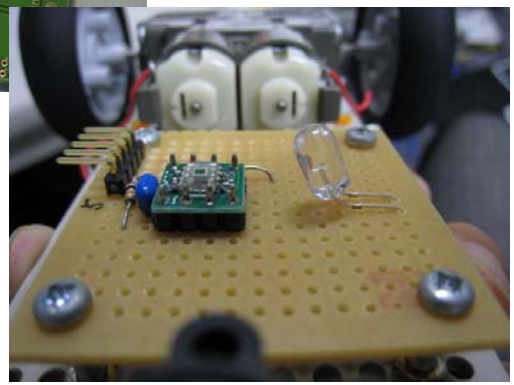


History of the material







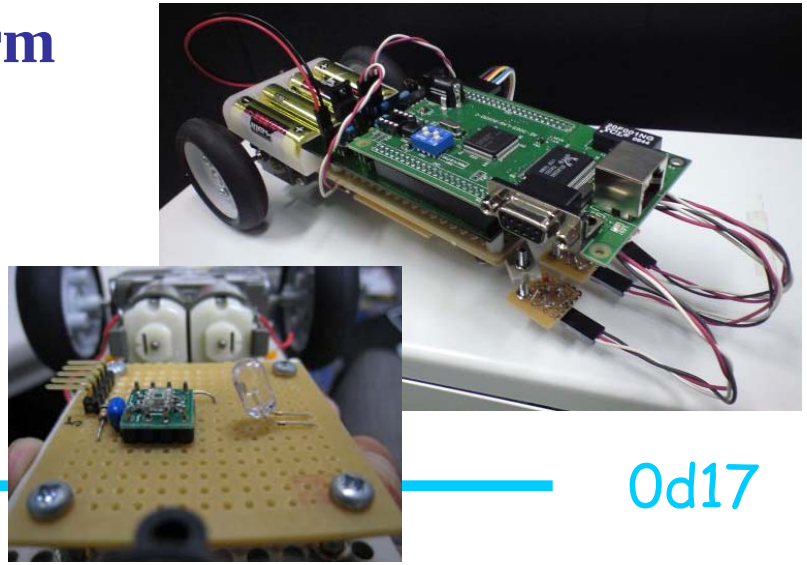


- SSEST1/2
  - (simple) line trace car
- SSEST3
  - yabusame-line trace car
- SSEST4
  - color-line trace car
  - original base-board kit

✓learning material has been developed for the better every year's committee

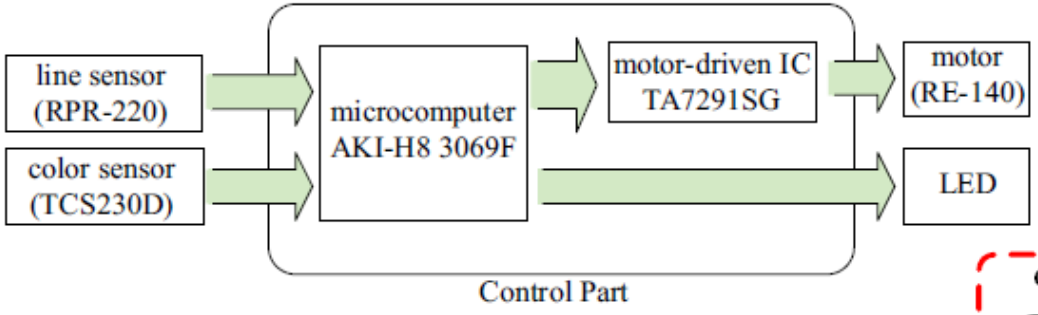
Why color-line trace car ?

- 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**

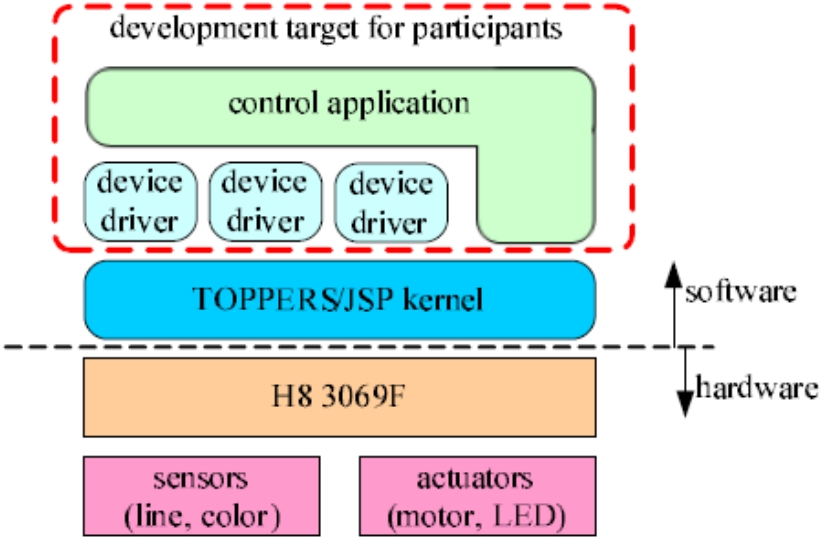


Inside of color-line trace car

- 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 participants 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

Part1: practice of making circuits
basic usage of microcomputer

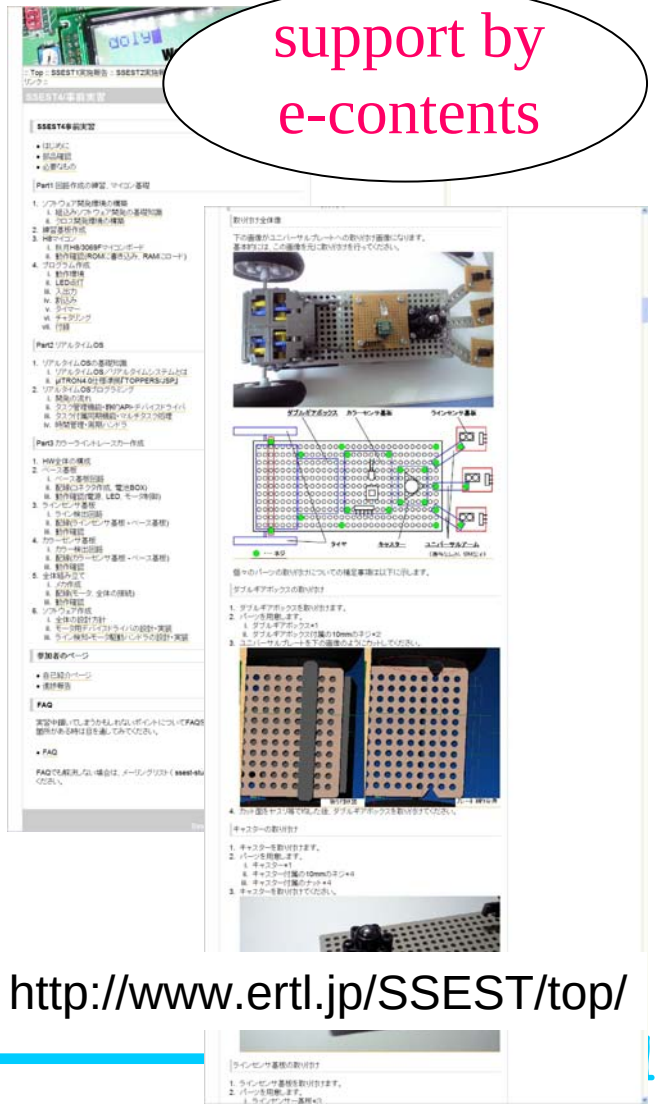
↓

Part2: programming with real-time OS

↓

Part3: make up the line trace car
program device driver & application

support by e-contents



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

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

Boot camp

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

Time	1st day	2nd day	3rd day
9:00		Practical training	Practical training
10:00		Designing	Coding, Testing
11:00		Documentation of specifications	Preparation for the presentation
12:00	Reception, Opening	Lunch	Lunch
13:00	Lecture 1: "What's Embedded and Real-Time System Development"	Practical training	Preparation for the debrief session
14:00		Documentation of specifications	Debrief session
15:00	Lecture 2: "How to Write Requirement Specifications"	Coding	
16:00			
17:00	Tutorial		
18:00			Dinner
19:00	Dinner, Fellowship banquet	Dinner	Race
20:00		Practical training	
21:00	Practical training	Coding	
22:00	Check of development environment		Closing

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

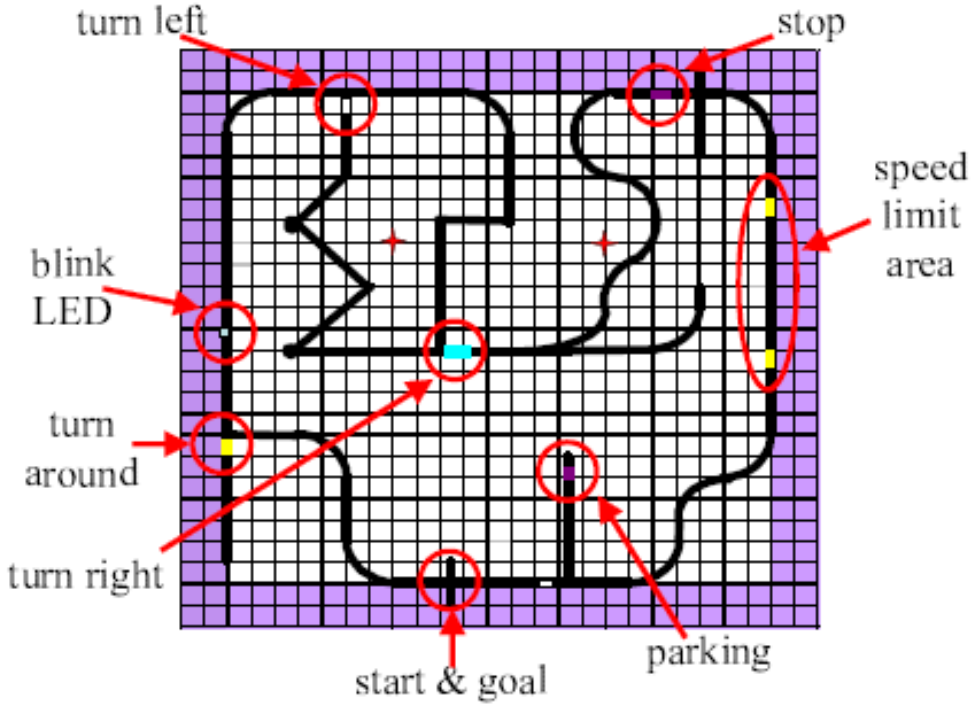
- Main activity of SSEST
  - four or five participants make up a team
    - **communication skill** of participant can be encourage to improve
  - design and implement a control programs of the line trace car
    - **experience** a series of an embedded system development process, e.g. waterfall, spiral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



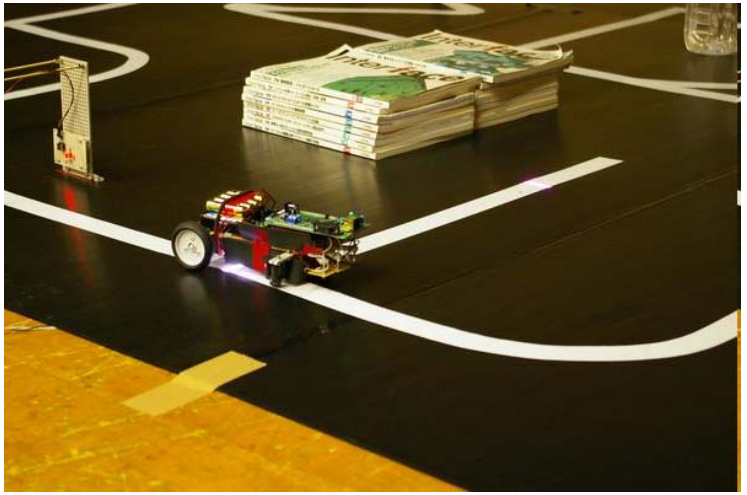


Table of contents

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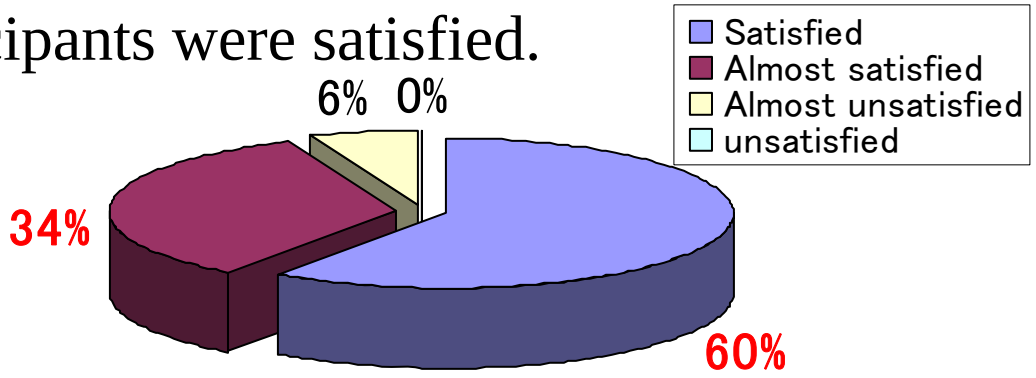
Analysis of educational effect

- We had sent out questionnaires from participants
  - for reviewing and improving our activity
  - total number of answers: 100
    - SSEST1: 27　SSEST2: 20　SSEST3: 25　SSEST4: 28

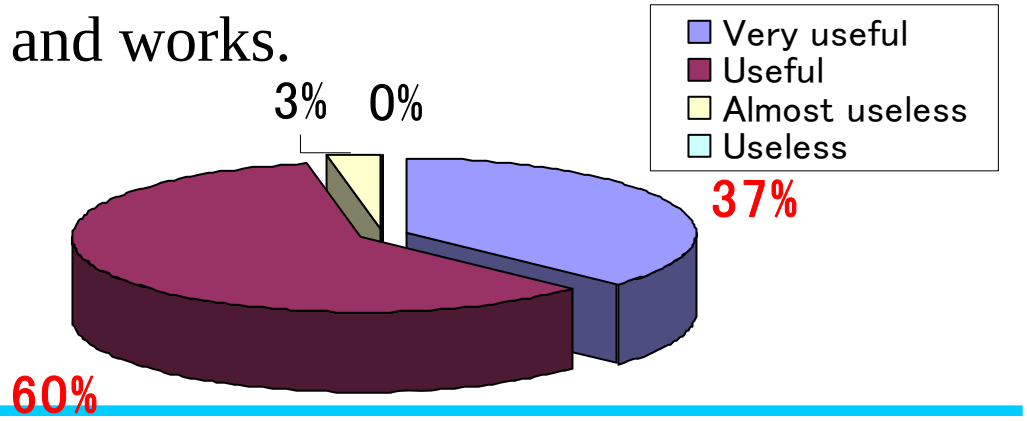
- Analysis items
  - Satisfaction
  - Usefulness of learning contents
  - Achievement of objectives

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

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

we could conclude this project got high appraisal

Table of contents

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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!!

Summer School on Embedded System Technologies
SSEST
Since 2005