RoboCup for science and engineering education: a case of the future University - Hakodate

RoboCup for Science and Engineering Education: A Case of Future University – Hakodate

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1 Introduction

RoboCup[1] is an international initiative for promoting science and technology mainly through the development of soccer robot. Due to the excitement of soccer, this activity provides ideal educational basis for science and engineering education at school and at home. In this paper, we will describe in depth, a case of new university in Japan, which is specifically designed to use the robot development process for RoboCup as a central scheme of education. In this university Future University – Hakodate (FUn@Hakodate, for short)[2], major part of classes are organized to use RoboCup for four year undergrad education. In addition, an entire campus is designed to maximize efficacy of RoboCup competition and daily education using RoboCup. Perhaps, this is the first university designed with Robot as the central scheme of education.

2 Overview of the University

2.1 Concepts

Future University – Hakodate (FUn@Hakodate, for short) is a new university which is going to be opened in April, 2000. The authors have been working on the creation of the master plan for FUn@Hakodate since 1996, as members of the executive planning committee of the university. The preparation of this university had been started to develop the educational curriculum for information science, and it has been extended for the area related with information science. For example, we have to study not only 'how to use computers,' but also 'what to use computers'; such as computer art, computer communication, and computer for intelligent robotics. We also have to study about the human beings, since those who use computers are the human beings. FUn@Hakodate intends to organize the education courses and study areas in information sciences including these various areas, with the concept of 'computer sciences.'

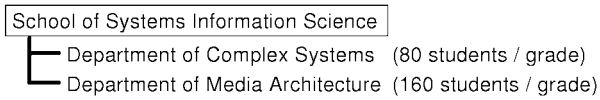


Figure 1: Faculties of FUn@Hakodate

One of the most important learning methodologies in FUn@Hakodate is 'project' based learning[3, 4]. The students learn not only by attending lectures, but also by crafting, such as computer programs, robots, artistic objects, by themselves. The students will have to do the project by cooperating with the other students in the same group, because some of the project tasks may be beyond the breadth and capability of a single student alone. The students will also have to gather their knowledges and ideas for achieving one project; for example, for making intelligent robots, they will have to use the knowledges and the technologies of electronics, computer programming, and mechanics, and so on.

We provide some themes of the project (the students can also develop the themes, of course), developing robots for participating RoboCup will be one of the most suitable themes for this project learning in terms of the concepts of FUn@Hakodate and the difficulties to challenge.

2.2 Faculties

FUn@Hakodate has two departments under one faculty, 'the School of Systems Information Science,' as shown in Fig.1.

One department, 'Department of Complex Systems'

aims to treat the complex sciences, the complexities in brain science, natural phenomena, and economical phenomena, and so on. It will use the computers for analyzing, simulating, or controlling them.

Another department, 'Department of Media Architecture' aims to 'construct' the information systems and information space, with considering the human activities. The students will be required to develop the faculties of merging both the knowledges and technologies through information science, and the viewpoint of the comfortableness and the functionalities of the computers for human, such as human interface or design, in one concept of using computers. There are three typical courses of learning in this department; for the intelligent systems, for computer systems, and for designing using computers.

The goal of the FUn@Hakodate is to provide top-level educational opportunities for students using the combination of project-oriented education and basic model of learning in multiple fields. The emphasis is on acquisition of the high quality knowledge and skills to explore and learn unknown and interdesciplinary fields. To attain this goal, all students in the department of Media Architecture is supposed to study basic course of design and architecture, computer science, and electric engineering.

The Department of Media Architecture aims at education of students who can design a framework of inteaction of design, space, and technologies, in the context of digital era. Skills in the narrow area of design and computer science is not sufficient to propose and conceptualize new framework where digital technologoies drastically change the nature living and social space around us, and the way we interact with such an environemnt and digitalized physical and virtual objects.

3 Curriculums

3.1 Common curriculums

Table 1 shows the main parts of common subjects for both departments.

The students in both departments should learn the overview of topics in both department, as well as the basic of mathematics, physics, and electronics, and so on. They also have to acquire the skills of communications; not only for the conventional conversations, but also for the scientific and technological discussions, in not only Japanese, but also English.

After learning these subjects, the students will start to learn the specialized subjects of the department where they belong.

Table 1: Common subjects for both departments('◯' indicates the required subjects, and '△' indicates the optional subjects)

categories	subjects
Humanities	◯ Introduction to mathematics
	◯ Introduction to physics
	◯ Introduction to electronics
	◯ Entrepreneurship
	△ Psychology
	△ History of art
	△ History of science
	△ Lifelong education
	△ Environmental science
	△ Outline of biology
	△ Outline of modern architecture
	△ Computer history
Communication ability	◯ English composition
	◯ English conversation
	◯ English reading comprehension
	◯ Speech communication
Common specialized subjects	◯ Computer literacy & practice
	◯ Algorithm and information theory
	◯ Programming concepts & practice
	◯ Introduction to complex systems
	◯ Introduction to information architecture

3.2 Learning course for RoboCup

Table 2 shows the learning model of choosing subjects for developing intelligent robots for RoboCup.

The students learn basic theories of electronics and AI by the subjects of 'Digital logic circuit', 'Artificial intelligence I' in the first semester of the 2nd grade, as well as the programming techniques for implementing AI by 'AI programming'

In the latter semester of the 2nd grade, they begin to learn the advanced topics of AI by 'Artificial intelligence II' and the theory and technologies of sensors for robots by 'Electronic sensor engineering.' Here, they are ready to learn more about developing intelligent robots from viewpoints of both software and hardware.

According to Table 2, in the first semester of the 3rd grade, they begin to learn the technologies of implementing intelligent multi agent system by 'Autonomic systems' and 'Parallel distributed processing.' They also learn the theory and application of image processing by 'Image Processing.' At this point, the system will be implemented only in software, since they have not learned to develop the real robots yet. They also begin the 'project' by 'System information science practice I,' and development of soccer agent of RoboCup Simulator League will be on of the most suitable themes of the project.

In the latter semester of the 3rd grade, the students

Table 2: Learning model of subjects for RoboCup (subjects in italic face represents the subjects relating with RoboCup)

grade	subjects
2/f	◯ *Digital logic circuit*
2/f	◯ *Artificial intelligence I*
2/f	△ *AI programming*
2/f	△ System management practice
2/l	△ *Electronic sensor engineering*
2/l	△ *Artificial intelligence II*
2/l	◯ OS theory
2/l	◯ Network communication theory
3/f	△ *Autonomic systems*
3/f	△ *Parallel distributed processing*
3/f	△ *Image Processing*
3/f	◯ Human interface
3/f	△ Database engineering
3/f	◯ *System information science practice I* (project base)
3/l	◯ *Robotics I*
3/l	△ Computer architecture
3/l	△ Software engineering and methodology
3/l	◯ *System information science practice II* (project base)
4/f	△ *Robotics II*
4/f	△ *Distributed coordination system*
4/f	△ Compiler theory
4	◯ *Preparation of thesis*

begin to learn the technologies and theories for implementing the real robots by 'Robotics I', and they also begin the next project of implementing the real robots by 'System information science practice II.' It will be too difficult to implement the real soccer robots of RoboCup, such as in Small-size, Middle-size, Legged and Humanoid, but the will learn much about the technologies for real robots at this project.

At the final grade, the students have to begin the preparation of thesis, and some students who belong to the laboratory of intelligent robotics will challenge the the theme of implementing the multi agent system of real robots, with using the total knowledges and technologies they have learned. At the first semester of this grade, they can also choose the advanced topics of multi agent systems of real robots by 'Robotics II' and 'Distributed coordination system.' The development of real soccer robots system of RoboCup real robots league will be one of the most suitable theme.

It is notable that the students have to, or can study the computers deeply at ech semester; the system managing techniques by 'System management practice', 'OS theory', 'Network communication theory' in the 2nd grade, 'Human interface', in terms of the relation with the human, 'Database engineering', 'Computer architecture', 'Software engineering and methodology,'

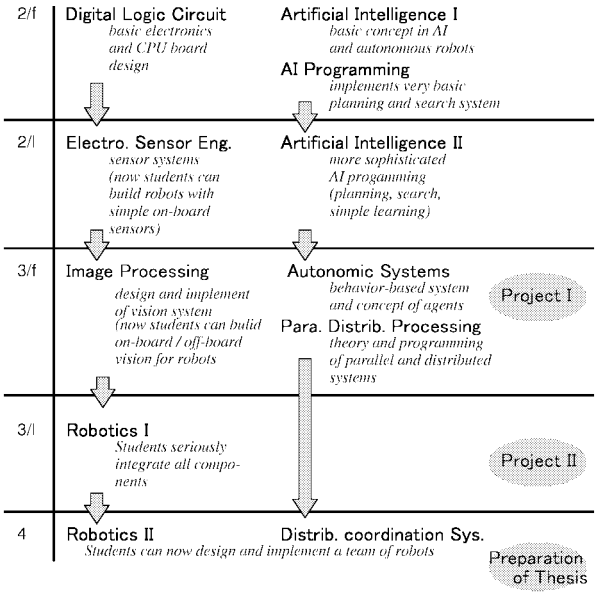


Figure 2: Learning flow of subjects for the course of RoboCup

in the 3rd grade, and 'Compiler theory' in the final grade.

Figure 2 shows the summerized learning flow of this course.

3.3 Other learning courses

In the department of Media Architecture, there are two other typical model of choosing subjects for the computer communication specialists and computer designers. Table 3 shows the model courses for them.

Model A is the choosing model for computer communication specialists, for example they should learn 'Media theory', which treats the computer based media, or 'Database engineering', and so on.

Model B is the choosing model for computer designers, for example they should learn 'Design history', 'Chromatics', 'CG theory' for basic skill of design using computer, and 'User-centered design' for developing computers useful for the human who uses them.

4 Campus

FUn@Hakodate locates at Hakodate City in Hokkaido, Japan, as shown in Fig.3. It stands on a small inclined hill in the outskirts of Hakodate City, and the building has the structure like a huge stairs, as shown in Fig.4.

Figure 5 shows the main parts of floor plans of each floor. More than the half of the Level 2 is buried, because of the inclined ground surface, higher at right-hand and lower at left-hand in Fig.5. In front of the

Table 3: Learning model of subjects for other courses (model A is for computer communication specialists, and model B is for computer designers)

gr.	subject	model A	model B
2/f	Digital logic circuit	○	○
2/f	Artificial intelligence I	○	○
2/f	System management practice	△	△
2/f	Basic info. presentation	△	△
2/f	Design history		△
2/l	OS theory	○	○
2/l	Network communication theory	○	○
2/l	Information design I	△	△
2/l	Communication theory	△	
2/l	Media theory	△	
3/f	Human interface	○	○
3/f	Sys. info. sci practice I	○	○
3/f	Database eng.	△	
3/f	Information design II		△
3/f	Advanced image topics		△
3/f	Chromatics		△
3/l	Sys. info. sci practice II	○	○
3/l	Robotics I	△	△
3/l	Computer architecture	△	
3/l	Software eng./method.	△	
3/l	CG theory and practice		△
3/l	Phonetic/music processing		△
3/l	User-centered design		△
4	Preparation of thesis	○	○
4/f	Compiler theory	△	

Figure 3: Location of FUn@Hakodate

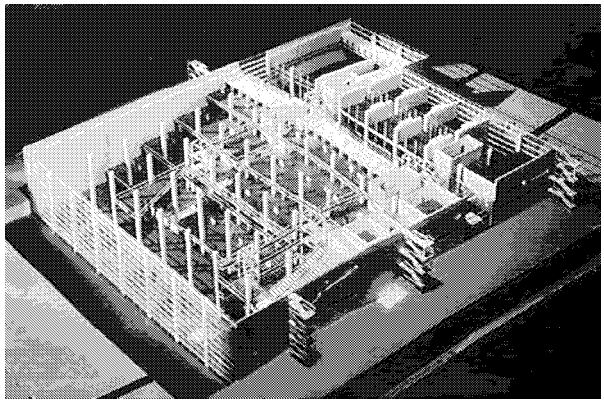


Figure 4: Photograph of FUn@Hakodate's building structural model

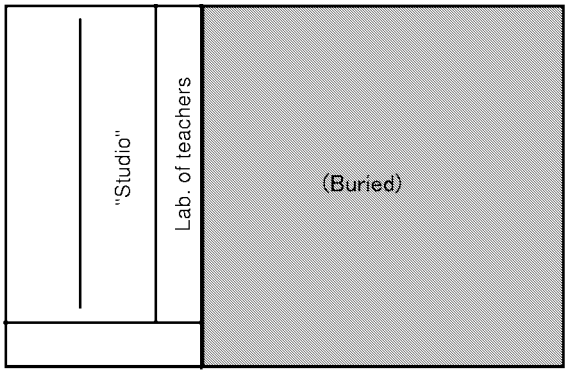
teachers' laboratory, there is a big open space, called 'studio', whose ceiling reaches the top of the building. We can design the learning space freely in 'studio' by placing tables, chairs, and moving walls suitable for the purpose of learning, such as project based learning. The students will do their works at the 'studio' using the notebook computers, and so on. The 'studio' spreads like a huge stairs according to the levels.

There is a big 'multi-purpose space' as a main corridor of the building, and the computer rooms, the arena, the large lecture room, electronic and mechanic laboratories, CG and AV rooms are all facing the 'multi-purpose space.' These spaces can be combined when the a big competition, such as RoboCup will be held at FUn@Hakodate.

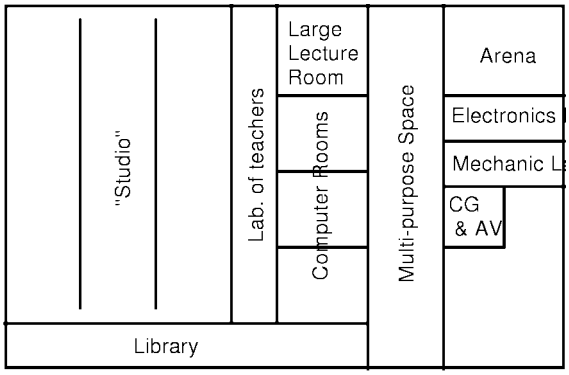
In case of RoboCup competition, the Simulation League will be held at the computer rooms, and the real robot league will be held either at the arena or at the multi-purpose space, and the arena and the multi-purpose space can be joined by opening the doors of the arena. The mechanic and electronic laboratories can be used for the pit of each team; they can make mechanic and electronic troubleshootings at these laboratories. The CG and AV rooms will be useful for generating real-time relay of the competition, or the usage of autonomous relay system.

5 Summary

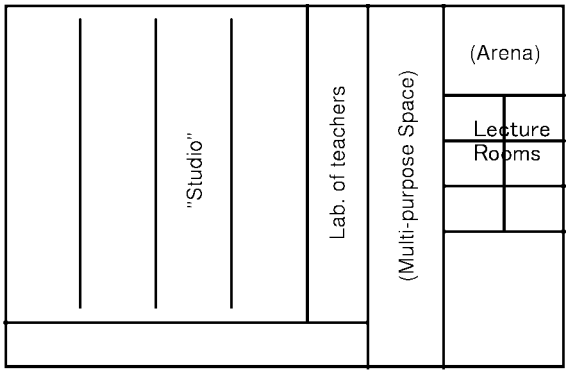
In this paper, we described the newly starting university in Japan, FUn@Hakodate. The concepts of FUn@Hakodate is to gather the various areas concerned with the computers, and one of the most important themes is learning through 'projects'. In the learning curriculums of FUn@Hakodate, the students can have the clear aims to learn basic scientific and engineering theories, such as mathematics, by having the



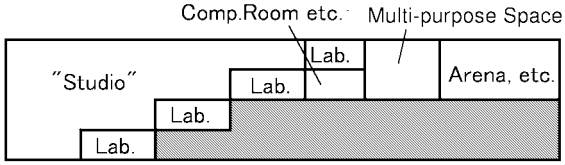
(Level 2 top view)



(Level 3 top view)



(Level 4 top view)



(Side vide)

Figure 5: Top views and side view of the building

viewpoints of clear applications using 'projects' at first, while the students have to learn the theories at first before having clear aims of applications in the most curriculums of conventional universities. The development of RoboCup, both the simulation league and the real-robot league, will be one of the most suitable themes for 'projects' in FUn@Hakodate. The students who chose the intelligent robotics course will learn the intelligent robotics, from the viewpoint of both software and hardware.

We also described the campus, that is useful for various conventions; RoboCup competition will be one of them.

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