

# Big Differences in the way of studying between Japan and Europe

Osaka university

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## 1. Personal data

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## 2. Executive Summary

I stayed Nederland from 1st September 2004 to 27th December 2004 and Denmark from 27th December 2004 to 31th January 2004.

I researched “New algorithms to solve BMI problem” in TU Delft. It will be a part of graduated thesis. I took 3 lectures in TU Delft and 1 lecture in DTU. Level of lectures in TU Delft and DTU are not so different from that in Japan. I only had a problem to write my answer in English. But I could get all of the grades. I also took 2 English lectures a week though I could not be allowed to get the grades. One is a lecture in TU Delft and the other is in ING that is a private organization. I think that they are very effective to improve English because I had opportunities to speak and hear English and also the lectures were very enjoyable.

I found some big differences between Japan and Europe. I write down them as follows.

- There are many practices and the maneuvers in European lecture.

In Europe we cannot get the unit by only attending the class and taking the test. In order to get the credit, we need to attend the class, to submit reports that are made from the maneuver and to take the test. I think these systems are lack for Japanese university.

- European student's motivation is different from Japanese one.

In Europe whenever the teacher questions during the lesson, someone positively answers the question in Europe. I wonder why Japanese students choose the lectures by judging the ease of taking the credit. I think this idea of Japanese students is very dangerous.

- There are many group works.

I was surprised at an interesting lecture of designing by the group work. In the lecture the teacher explained only the outline of the lecture, and then we have to design what we were given in our groups. I thought that I hardly took such a interesting lecture in Japan. This lecture enabled us to strengthen debate and presentation and so on.

- There are unpalatable foods and bad service in Europe.

I had problems to have a meal in Europe because the food in restaurant is very expensive and the lunch in TU Delft is not delicious. During the stay I missed

Japanese foods. In addition European clerks are not polite compared with Japanese one. They often made me a little bit annoy.

### 3. Travel Schedule

TU Delft : From 1st September 2004 to 27th December 2004

DTU : From 27th December 2004 to 31th January 2004

### 4. Research or Lectures

I researched and took 3 lectures in TU Delft and took 1 lecture in DTU. Let me show the contents of my research and 3 lectures of TU Delft in 4-1 and the content of 1 lecture of DTU in 4-2. In addition I denote what I felt and the differences between Japan and Europe in 4-3.

#### 4-1. Research or Lectures in TU Delft

- **Research**

- *Introduction*

In this project we considered algorithms for  $H_\infty$  optimal static output feedback problem based on sequential LMI optimization.

$H_\infty$  controller synthesis is an attractive model-based control design tool. It allows incorporation of modeling uncertainties in control design. One of the reasons that  $H_\infty$  controller has not yet been widely used in industry is the high order of the resulting controller.  $H_\infty$  synthesis without additional complexity constraint yields in general a controller order equal to  $n$  the order of the dynamical model plus the order of the weighting functions. The computation of the controller action in implementation on systems with a very high sampling rate, the need for low-order controllers is obvious. But this problem is BMI problem which is not easy to solve.

In order to solve this problem we apply a method based on Finsler's method for this BMI problem. Moreover we considered the existing methods (XK-iteration, Path-following) which solve BMI problems. In order to speed up the calculation time, we combined them with a dedicated solver for LMI problems arising from the KYP. By using these methods, we solved the  $H_\infty$  static output feedback problem for a system with McMillan degree 4 and compared the results.

- *Problem formulation*

Consider the system depicted in Fig.1.  $P(s)$  is given by

$$\begin{bmatrix} \dot{x}_p \\ z \\ y \end{bmatrix} = \begin{bmatrix} A & B_1 & B_2 \\ C_1 & D_{11} & D_{12} \\ C_2 & D_{21} & 0 \end{bmatrix} \begin{bmatrix} x_p \\ w \\ u \end{bmatrix} \text{ and } K \text{ is static output feedback gain.}$$

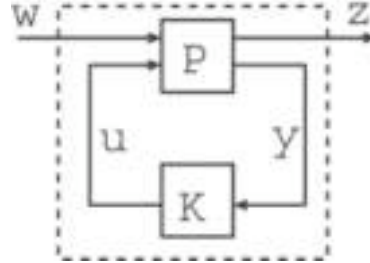


Fig 1. Generalized plant

In this case, we have the closed-loop systems as the following state space representation:

$$\begin{aligned} \begin{bmatrix} \dot{x}_p \\ z \end{bmatrix} &= \begin{bmatrix} A + B_2 K C_2 & B_1 + B_2 K D_{21} \\ C_1 + D_{12} K C_2 & D_{11} + D_{12} K D_{21} \end{bmatrix} \begin{bmatrix} x_p \\ w \end{bmatrix} \\ &= \begin{bmatrix} A_{cl} & B_{cl} \\ C_{cl} & D_{cl} \end{bmatrix} \begin{bmatrix} x_p \\ w \end{bmatrix} \end{aligned}$$

Here we consider  $H_\infty$  controller static output feedback problem: The purpose of this problem is to obtain the stabilizing controller which minimizing  $H_\infty$  norm from  $w$  to  $z$ . This problem is equivalent to finding  $X > 0$ ,  $K$  and

$$\begin{bmatrix} A_{cl}^T X + X^T A_{cl} & X B_{cl} & C_{cl}^T \\ B_{cl}^T X & -\gamma I & D_{cl}^T \\ C_{cl} & D_{cl} & -\gamma I \end{bmatrix} < 0$$

such that the above equation holds. Note that  $A_{cl}$ ,  $B_{cl}$ ,  $C_{cl}$ ,  $D_{cl}$  depend on the controller  $K$ .

#### • Application

In order to solve this  $H_\infty$  problem which is BMI problem, we considered 5 methods: Finsler's method, XK iteration method, Path-following method and 2 combined methods. We propose Finsler's method. This method can deal with larger class than BMI. On the other hand the number of LMI is larger than that of other methods. XK iteration method and Path-following method are used for BMI solver so far. We remark KYP method which is known as the more efficient solver than

LMI solver and combined it with XK iteration method and Path-following method. These are combined methods.

Here for the convenience of space, I explain only KYP method.

• *KYP method*

In this method, we can efficiently solve LMIs with a special structure. This method solve

$$\text{Find } X, \text{ s.t. } \begin{bmatrix} A_{cl}^T X + X A_{cl} & X B_{cl} \\ B_{cl}^T X & 0 \end{bmatrix} + M < 0.$$

In terms of  $H_\infty$  problem, we can obtain the form of KYP as follows.

First we apply a shur complement for  $H_\infty$  problem. Then we get

$$\begin{bmatrix} A_{cl}^T X + X A_{cl} & X B_{cl} \\ B_{cl}^T X & -\gamma I \end{bmatrix} + \begin{bmatrix} C_{cl}^T \\ D_{cl}^T \end{bmatrix} \left( \frac{1}{\gamma} \right) \begin{bmatrix} C_{cl} & D_{cl} \end{bmatrix} < 0.$$

Then we multiply  $\gamma$  to the above equation and recast  $Y = \gamma X$  and  $\beta = \gamma^2$ . Thus we obtain the following KYP form.

$$\text{Find } X, \text{ s.t. } \begin{bmatrix} A_{cl}^T Y + Y A_{cl} & Y B_{cl} \\ B_{cl}^T Y & -\beta I \end{bmatrix} + \begin{bmatrix} C_{cl}^T \\ D_{cl}^T \end{bmatrix} \begin{bmatrix} C_{cl} & D_{cl} \end{bmatrix} < 0.$$

Note that this method can solve LMI efficiently but  $Y$  is not always positive matrix. So we have to be careful for  $Y$ .

• *Numerical example*

We denote the result of solving  $H_\infty$  problem by using "Finsler's method", "XK-iteration method", "Path-following method", "XK-KYP method" and "Path-KYP method". We compared the CPUtime and the  $H_\infty$  norm which is obtained by each methods. We use the objective plant of the model of logitudinal motion of VTOL helicopter. Then we got the following result.

Table.1 : The comparison of each method

	Finsler's	XK-iteration	Path-following	XK-KYP	Path-KYP
$H_\infty$ norm	0.173	0.15640	0.15457	0.15646	0.15456
CPUtime	2655.4	14.5610	5.157	24.195	17.4150
Iteration	48	47	24	44	23

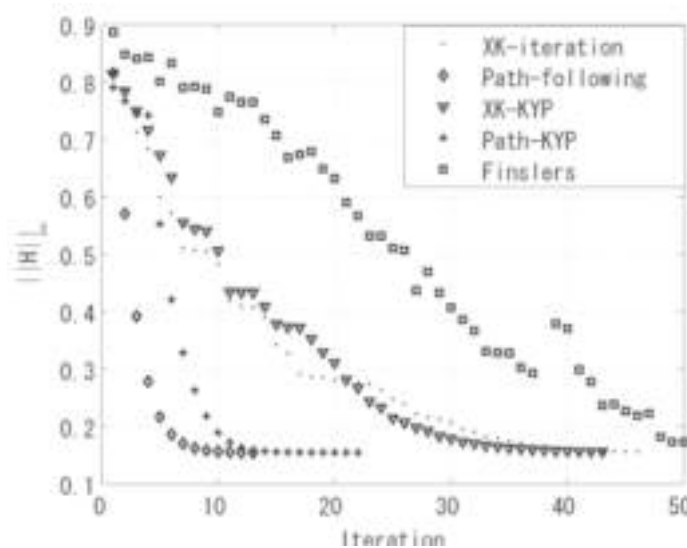


Fig.2 : Iteration v.s.  $H_\infty$  norm performance

Table.1 shows the comparison of  $H_\infty$  norm, CPUtime, iterations and Fig.2 shows one example of the relationship between iterations and  $H_\infty$  norm performance in each method. We can find that the movements in Path-following and Path-KYP is similar and the movements in XK-iteration and XK-KYP is as well. We also find that Path-following method is better than other solutions.

Finsler's method takes much time compared with other methods, because we have to deal with larger matrix and larger number of variables in Finsler's method than in other methods. But in this method we can obtain the controller which has almost same performance as one in other methods. It is very good results. Because in Finsler's method, we can deal with larger class of problems that can not be solved by using other methods.

• *Summary*

Finsler's method takes much time compared with other methods. It is because we have to deal with larger matrices and larger number of variables in Finsler's method than in other methods. But in this method we can obtain the controller which almost has the same performance as with other methods. Furthermore Finsler's method can be applied to a much larger class of problems.

We guess that the combined methods (XK-KYP, Path-KYP method) can get a controller faster than Path-following method because KYP solver is more efficient than LMILAB solver. However we got the results that Path-following method is faster than the other methods. We have to investigate why it occurs.

- **Lecture**

1. *Control Theory*

This course serves as an introduction to the concepts and techniques currently used in basic modern control theory. The course requires the development of the technical skills involved in state space system theory. It also extends the notions of control system design toward time-domain techniques based on pole placement and linear optimal control using quadratic performance criteria. The exercises in the course stress the use of a computational linear-algebra environment for linear control system design. The exercises make us familiar with model-based control design, supported by modern computation tools for dynamic analysis, simulation and control performance assessment.

2. *Optimization in systems and control*

This course is divided into 2 parts. One is optimization techniques and the other is applications in system and control.

In the formal part we studied various techniques to solve optimization problem. For example Linear programming, Quadratic programming, nonlinear optimization, global optimization methods and so on. In the latter part we consider the Multi-Criteria Controller Design and solve it in a exercise.

3. *Biomedical engineering design*

In this course we study the various mechanisms which are involved in medical engineering. In my case we designed the new mechanism of a prosthesis. In order to do it, we decided the problem definition and think about a lot of conceptual solutions and then find the most effective solution.

#### **4-2. Lecture in DTU**

1. *Laboratory Course in Process Simulation*

The course is divided into three parts covering simulation of metal casting, plastics casting and metal forming. Each part starts with an introduction to the process

followed by an exercise where the process is simulated. A small report must be delivered in the end of the course. There are 2 main objectives in this course. One is to make us familiar with some of the most important computer programs for simulation of metal casting, die casting of plastics as well as mechanical forming of metals. The other is to enable us to make simple computer simulations with these programs.

#### **4-3. The differences in the way of studying**

I took only four lectures in Europe. I think this is enough to realize the differences between Japan and Europe. I have 3 main opinions about the differences. First I was surprised to do many practices and the maneuvers. I cannot get the credit by only attending the class and taking the test in Europe. In order to get the credit, we need to attend the class, to submit reports which are made from the maneuver and to take the test. Especially, one class needed that I had to discuss reports with the teacher in order to check whether I could really understand the lecture. Although I spent on studying the lecture, I think I made progress by this lecture policy. Secondly there is a difference of student's motivation. Whenever the teacher questions during the lesson, someone positively answers the question in Europe. I wonder whether the Japanese students who choose the lecture by judging the ease of taking the credit, is really good. Thirdly I was surprised at an interesting class of designing by the group work. In the lecture the teacher explained only the outline, and then we have to design what we were given in our groups. I thought that I hardly took such a interesting lecture in Japan. The lecture enabled us to strengthen debate and presentation.

#### **5. Exchange student life**

What was most astonishing for me was that universities in the Netherlands, for example, TU Delft were not accessible on weekend. When I asked about it a professor at the university, he answered "Here is Holland. Why don't you enjoy your life?". Then I realized that almost all the shops in the Netherlands were closed by 18:00 and TU Delft was not accessible on weekend. They spend their time on their leisure activities with their family. I found this culture is quite different from that of Japanese. Before I went to the Netherlands, I took it for granted that most professors and students come to laboratories and do their studies or work even on weekend. However, such ideas are very new to me and broadened my mind.



Actually I did not have any serious problems in the life in the Netherlands. However, one problem for me was the food. The food does not suit my taste. In addition when we had meals in a restaurant, each meal costs around 1500 yen. The food in a restaurant in TU Delft is also expensive for students. Therefore, I had to go back my dormitory during lunch time and make a meal by myself.

In 4 months' stay in the Netherlands, I made friends with many other students through football and having a drink almost every weekend. Such activities let me relaxed and helped me to make progress in English. Moreover, I attended ING: a private organization for events, and then I was able to take an English lecture and have a Christmas party. I felt something familiar to the culture in the Netherlands greatly.

Since in Denmark I stayed only for one month and took three weeks' lectures at the university, I was very busy and was not able to spend time like I did in the Netherlands. I woke up early morning, went to university, took three weeks' lectures, studied by myself and went back to my dormitory. I repeated this cycle for three weeks. In the three weeks' lectures four Japanese students including me have to do some tasks together. Therefore, I did not have to use English.

In Denmark I had troubles about a bicycle and the expensive cost of living. DTU was a large university and it took twenty minutes to go to DTU from my dormitory. Then I thought it was necessary to have the bicycle for comfortable life. I borrowed a bicycle from a friend. However, the tire of the bicycle got punctured three times for one month. This was unbelievable for me. Even though I complained about that at a bicycle shop, they were not willing to help me at all. I was surprised at their attitude and came to realize the differences of services between Japan and Denmark.

## **6. Suggestions to the Project**

- In Holland I lived with Japanese guy. So I could not speak English in my house and make foreign friends. So I wish I lived with foreign people.
- I think there are a lot of foreign people in Osaka University. So before going to Europe, we should have had the opportunity to talk with them.
- In September we could not get money. So I think that the time when we can get money should be announced in advance.

## **7. Summary**

This project enabled me to have quite good experiences. I felt something familiar to European culture in the Netherlands and Denmark and other foreign countries by talking to friends in the countries, and then I gained precious experiences thorough this project.

I considered that going abroad was a special experience before I went to Europe. However, actually this exchanging project made me find out that it was not extra ordinary experience all over the world. Now I think Japanese students are abnormal. For example Japanese students choose lectures by judging the ease to take the credit and there are few lectures where students can do many practices and the maneuvers. I consider that we should head toward international levels. Otherwise I think Japan will lose the competition of international companies.

Owing to this project I could grow more greatly than I was in Japan. I could find the crisis of Japanese students, lectures and the abnormality. I also found the better points in Japan than in Europe. I think I could not realize these things without going to foreign countries. I think these concepts will be needed if Japanese lead this world.

I really thought it was worthy for me to participate in this project.