

# JGP Internship at TU Ilmenau

Masanori Oshima

Process Systems Engineering Laboratory, Department of Chemical Engineering, Kyoto University

## 1. Background

I stayed at the Department of Automation Engineering of Technische Universität (TU) Ilmenau, Germany, from April 11th to September 29th in 2023 for JGP international research internship. TU Ilmenau is at Ilmenau in Thuringia, and Fig. 1 is a picture of Ilmenau. Prof. Yuri A.W. Shardt is the department chair and kindly accepted me to visit his department as a visiting doctoral student.

Prof. Shardt and I have been collaborating on the statistic modeling for dynamic systems, called system identification in my research region, since 2021, when the pandemic began. Hence, this was the first time for us to see each other in person, and this internship aimed to proceed with one of the research themes of our collaboration.

Prof. Shardt allowed me to attend the department's operations as well, which is usual for doctoral students in Germany, such as defenses of bachelor and master theses, including making scores of the defense presentations, supervising the examination for bachelor students, and departmental meetings. Through these experiences, I have learned a little about how the departments of German Universities are operated.

On the other hand, this internship was the first opportunity for me to stay in a foreign country for more than a week. Hence, there were many challenging things in my life during this period. This point will also be elaborated on later.



Fig. 1: A picture of Ilmenau where I stayed during my internship.

## 2. Department of Automation Engineering

Department of Automation Engineering belongs to the Institute of Automation and System Engineering, where research and education on systems engineering and control engineering are performed. The department was operated by the staff, including Prof. Shardt (chair), two research staff, four doctoral students (including me), two engineering staff, a secretary, and so on. Here, doctoral students are counted as the departmental staff because doctoral students in Germany are usually involved in the operation of the department, such as education-related things, as well as their research. Other doctoral students supervised master's and bachelor's students and are officially responsible for their theses. I attended several thesis defenses to make some comments for the students and the meeting to determine the score of the presentation part of their theses. The latter does not happen in Universities in Japan as far as I know, and it was a pretty interesting experience.

Another interesting difference was that master's and bachelor's students are not required to produce any achievement with academic novelty in Germany. Hence, no one asked questions like "What is the new point in your research?" or "What is the difference between your work and past works?" in the discussion of the defenses. Of course, it is not necessary for Japanese master's and bachelor's students as well. However, in Japan, it is considered better to do so, and the questions above are sometimes heard.

The offices and the laboratories of the department are in the building named Zusebau, whose picture is shown in Fig. 2. Note that the building is named after Konrad Zuse, the well-known German computer scientist, and, interestingly, most buildings in TU Ilmenau are named after famous scientists, such as Newton, Kirchhoff, Helmholtz, Faraday, and Heisenberg.



Fig. 2: The building including the department of automation engineering, TU Ilmenau. The name of the building is Zusebau in German.



Fig. 3: My office at TU Ilmenau.

My office was on the third floor of Zusebau, whose picture is shown in Fig. 3. This room was shared with another visiting doctoral student from China from July 2023. Before that, I was the only occupant of this room! It was a very convenient environment, which is hardly realized in Japanese universities. It helped me to focus on my research, such as thinking about new algorithms or theories, writing some things, and learning new things.

### **3. Research activity**

I have tackled the development of a new algorithm for the optimal design of system-identification experiments during this internship. The core concept of my method is focusing on the non-asymptotic properties of the system-identification model. The existing experiment design method is based on the asymptotic theory, where how the modeling error behaves as the number of samples goes to infinity is considered. However, such an asymptotic situation is unrealistic in many practical problems. Hence, I have developed a new algorithm that does not come from the asymptotic theory.

The algorithm's validity was clarified through an identification experiment using a three-tank system shown in Fig. 4. In my research field, system identification and process control, numerical experiments are also acceptable for validating the new method in many cases, on which my previous works relied. However, the result of actual experiments still gives more substantial evidence, and some journals require the experimental results to support the usefulness of the method. Hence, this internship contributed not only to the progress of my research but also to broaden my research experience.

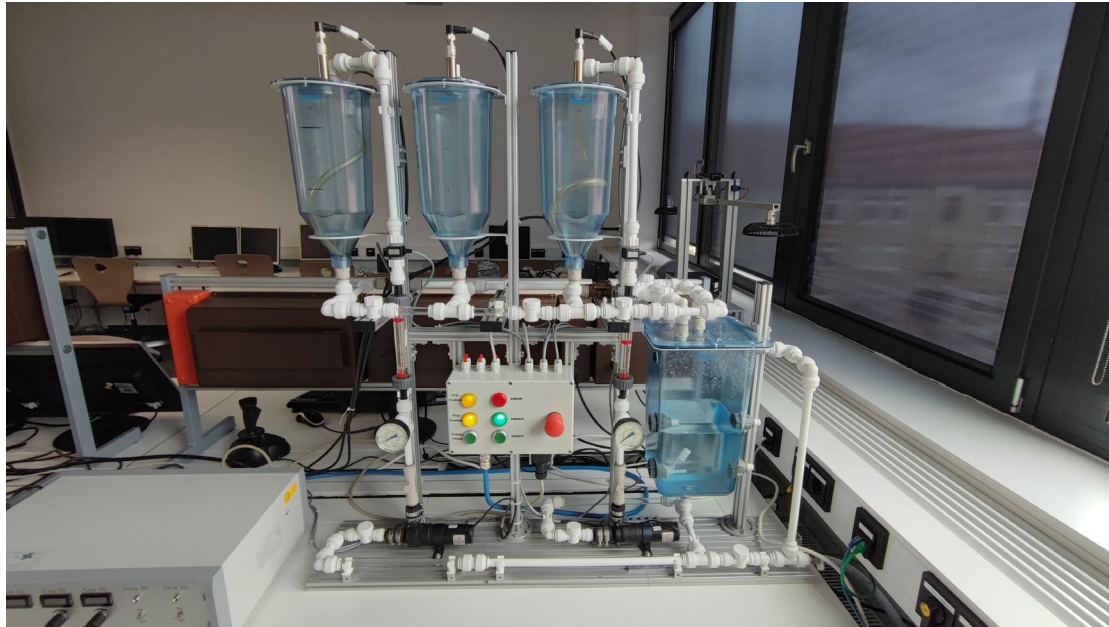


Fig. 4: The three-tank system used for demonstrating the validity of our proposed method.

#### 4. Daily-life in Ilmenau

Ilmenau is not a large city compared with other German cities, but, in my opinion, it is an excellent place to live. The city and its surroundings have plenty of nature, as shown in Figs. 5 to 8, which often relaxes me when walking. It indirectly helped me to keep myself committed to my research during the internship. Moreover, the city of Ilmenau includes sufficient places to make a living, such as supermarkets, post offices, banks, and offices of public services.

Hence, I have never had significant problems living in Ilmenau. However, if I had to pick one problem, I would say the application for the residence permit. For Japanese, staying in Germany for more than 90 days requires a residence permit in addition to a Japanese passport, and it can only be applied after you arrive in Germany. The procedure for this is as follows, with only which you can find the complexity of the process.

1. A blocked account in Germany was opened from Japan, and sufficient money was transferred to the account to get proof of the financial guarantee during my stay. Note that the blocked account can be activated only after arriving at Ilmenau.
2. Resident registration was applied at the residential office right after arriving at Ilmenau. The registration was canceled by myself before I left Germany in September 2023.
3. A free bank account was created to draw money from the closed account because money cannot be drawn directly from the closed account.
4. Registration to TU Ilmenau as a student was performed because the certificate of the registration to the university is required.
5. I went to the foreign registration office with the necessary documents and applied for the residence permit. And I got a fiction of the residence permit.



Fig. 5: Plenty of nature in Ilmenau

Note that it took me two months to finish all these steps.

### **Acknowledgements**

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