Report

DeMaMech EU-JAPAN Exchange Program

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1. Personal Data

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2. Executive Summary

Since the start of my studies, I knew that I wanted to study abroad during my studies. In my first year of specialization in Mechanical Engineering, I started researching possible study-abroad programs. These included contacting connections in the USA, where I have lived with my family for 8 years, and also included looking at possible Erasmus institutions. It was not until the spring of 2005 that the DeMaMech was brought to my attention and I was instantly hooked. After going through the very well organized TUDelft-DeMaMech website, which provides official information on the program, I knew that this program would provide me a chance to study in a country with a culture that I had not yet experienced in my life. Additionally, the focus on Design and Mechatronics made a perfect fit for what I was looking for in my studies as a Mechatronics engineer. Specific features of the DeMaMech program that were not offered by other exchange programs included the generous scholarship (but still a minimum to survive in a country as Japan), the excellent exchange agreements between host institutions making the transition to Japan as smooth as possible, the common interest between the students taking part in this exchange program and, lastly, the preparatory two-week introduction in Berlin, Germany. During these two weeks, the group of exchange students was taught some basic Japanese and immersed in the Japanese way of living. Insightful presentations were made by alumni of the exchange program. These presentations allowed us to catch a glimpse of what we could expect during our time abroad and also allowed the alumni to give out some specific, crucial tips and pointers to make the best of living together with Japanese people. All of these features of the exchange program led to an unbelievable successful exchange for me.

Naturally, any change such as this exchange brings along a lot of administrative work, stress and adjustment. However, I can honestly say that I cannot imagine a better transition than the one I experienced. Even before my arrival in Japan, the Keio International Center communicated with me to make sure that all paperwork was going along properly. All official papers were carefully sorted by them, with most of the information already filled in. In many cases I simply had to sign and send it back to the office. This may not seem like much, but with the language barrier that exists in Japan, it would be nearly impossible for me to do this alone. The International Center also arranged for my accommodations very close to campus and financially supported part of the dormitory cost. Additionally, a Japanese student was arranged to pick me up from the Yokohama Air Terminal. I found this particularly good since it allowed me to avoid being shocked by the completely different culture and language. The student showed me around some basic, but major, parts of the region as we made our way to my dormitory. The first impression was set: incredible!

Getting used to the Japanese way of living was not easy. A major contributor of this difficulty is the enormous language barrier. Communicating in English is almost impossible, so creativity is certainly needed. In these circumstances, our short introduction to Japanese during the summer in Berlin certainly paid of! Finding western food is difficult and often very expensive. The advantage of this is that I automatically tried out the Japanese cuisine from day one and I don't regret it a bit: delicious! Transportation in the Tokyo area is world-renown and trains run punctual within a margin of a few seconds. The extensive rail-network both in the Tokyo area and in the whole of Japan allowed me to get around quickly, easily and right on time. The biggest adjustment certainly was getting used to the Japanese way of interacting. This ranged from adjusting the way of greeting strangers with the right amount of respect to understanding what Japanese really mean. Since it is society built on the concept of respect, interacting was sometimes awkward and frustrating. Every day of the 5 month exchange, I was reminded of the differences between Belgium and Japan, and every day I appreciated the positive sides of both countries more. Going on about every single difference would overwhelm this report, but an overall discussion is presented later.

An important part of experiencing a country is also to travel around the country. Together with fellow international friends and Japanese friends, I got to see the most important parts of this beautiful country. This also allowed me to get a first-hand experience of traveling on Shinkansen, the famous Japanese bullet-trains taking loads of passengers from every part of the country in no time. Getting out of the hustle-and-bustle was a pleasant relief. What was especially striking was the contrast between metropolitan Tokyo (where I spent most of my time since the University is located

right next to it) and other parts of the country. Evidence of authentic and old temples, shrines and pagodas were found everywhere, often in harmony with modern skyscrapers as backdrop. The Japanese have certainly found a way to combine their highly technological society with their authentic and historic heritage.

3. Itinerary

April 1:

Brussels Zaventem airport to Japan Narita airport - arrive at 5:30 (lost luggage for 3 days, after which it was returned to my dormitory by the airline company)

April 28 - May 5:

Golden week: this is a week where all Japanese travel around the country. Even with all tourist brochures warning that traveling during this period might result in very crowded situations, this week of exploring Japan was extremely rewarding:
Tokyo - Kyoto - Nara - Osaka - Kobe - Hiroshima - Miyajima - Fukuoka - Beppu - Tokyo.

August 31:

Japan Narita airport to Brussels Zaventem airport

4. Academic activities

Lectures:

The academic component of the exchange mainly consisted of the following lectures. This is one of the reasons of my choice of Keio University. This university provides the most international courses in the engineering field, which means that the courses are taught in English when an exchange student is present in class. Overall, the level of English proficiency of the professors was average, but good enough to present the material in front of the class. What follows now is list of all 7 courses taken and a summary of what was covered, along with the evaluation criteria.

Computational Structural Mechanics
This theoretical course presented the linear and non-linear finite element methods. A strong matrix mathematical and linear algebra background was expected. At the end of every class a weekly assignment was given, which required several hours to solve. Usually the theory for the homework was not yet fully explained, which forced the students to look up information and understand the underlying principles. The final assignment was an analysis of a finite element analysis using provided software (MARC)

Aerospace Propulsion
This course was subdivided in three major sections: rocket nozzle theory, chemical combustion and trajectory path calculation. Tests were given from time to time (usually without notice) during the year and a major part of the evaluation was a final exam during the last class.

Advanced Course on Digital Communications Theory
This class focused on digital communication in general and indeed covered a wide array of applications. Modulation techniques were covered, with a focus on the Japanese standards and local integration of the technology. A comparison with other countries was also often made, utilizing the international students to ask feedback and input. The final evaluation consisted of giving a presentation in front of the class about a recent digital communication topic. I chose "WiMAX - an overview of the technology" as my topic and discussed the technology, along with the practical use and unique modulation schemes.

Advanced Design and Production System
This course consists of two main sections: tribology and multivariate systems. The first half was given using PowerPoint and students were asked to give a PowerPoint presentation about their research and the connection with tribology themselves. The second half was more theoretical and required a report of the students at the end of each section.

Wireless Communication
This class focused on wireless communication techniques. A broad overview of antennas and adaptive antenna arrays was given before discussing the different wireless communication modulation schemes. The theoretical background of wireless transmission was also given, including a discussion of frequently encountered problems when transmitting wirelessly in metropolitan areas. The evaluation was based on a final exam.

Design of physically grounded communication system
This course basically discussed the major Artificial Intelligence theories and was given using PowerPoint presentations. Practical examples, using video, were very good at showing the interaction between humans and robots. Different program architectures of simulating human reasoning using robots were presented. Two major reports which covered all the theories were used for evaluation of this course

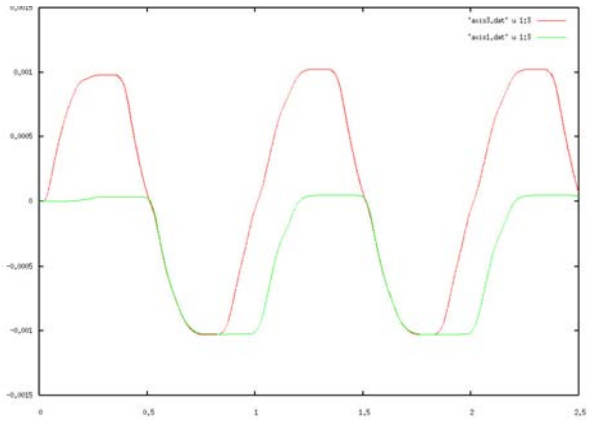
Special course on Computer Architecture
The connection between multiple Computer Processing Units was discussed in this course. Different kinds of architectures were discussed, with an emphasis on memory interaction and the different kinds of parallel computing. These were also linked to practical examples currently used in the world. At the end of the lectures, an exercise that was to be solved in class was given. At the end of the course, a major programming exercise was given. The aim of the project was to write a program, which utilized 8 processors simultaneously with local memory to transform an 8192 x 8192 matrix using Discrete Fourier Transformation. Since this usually takes several days to complete, heavy optimization had to be performed, along with parallel programming. A very difficult task, but very rewarding when finally solved!

Research:

Although the focus of my academic activities at Keio University was taking lectures, I also conducted research. I was able to get assigned to a lab that specialized in my master thesis interest, planned for the academic year 2006 – 2007. This allowed me to observe activities at this laboratory and participate in research activities, all aiding my understanding on the subject of 'Master/Slave systems and Bilateral Control'. My laboratory is supervised by Prof. Kouhei Ohnishi and is part of the System Design department. It mainly focuses on master/slave system, otherwise also known as bilateral control. The laboratory is particularly known for its use of a 'Disturbance Observer' in bilateral control applications. In short, this type of control allows very precise bilateral control without the use of force sensors. Only a position sensor is used on both master and slave side, along with a linear motor. Getting into detail of this control system would exceed the purpose of the report. Rather, a summary of my research activities at the laboratory is given.
An important part of the lab activities is attending 'SUM', which is the name given to a group of 4 laboratories joining in their efforts to optimize bilateral control and control system applications. Every Wednesday and Thursday, all lab members are required to listen to presentations given by fellow lab members on their research. These presentations are done in English and last about 3 hours. Although the presentation itself is given in English, mainly to promote the use of English for Japanese students, the discussion afterwards is done entirely in Japanese. This makes it hard to understand what the feedback on the research is, but the international students often read research papers during that time. For me, SUM was a time where I could observe the Japanese way of doing research and interaction with each other.
In the lab, I divided my time doing two kinds of research. Since the lab was so closely connected to my thesis topic, I was able to start my literature study for my master study. I read numerous papers on the topic of Haptic Displays and the human sensing properties (nervous system in fingers) and summarized my findings. This combined with communicating with a doctoral student supporting me from Belgium, I was able to get a good overview of the contents of my master thesis. What was also especially supporting was the fact that I was constantly surrounded with students interested in the same field. In the lab I was able to ask input from students working on other aspects of haptic displays. Moreover, some students at the lab are studying and researching problems associated with haptic displays. Being aware of the very existence of these problems also allows me to plan ahead of those while moving on with my master thesis in Belgium.

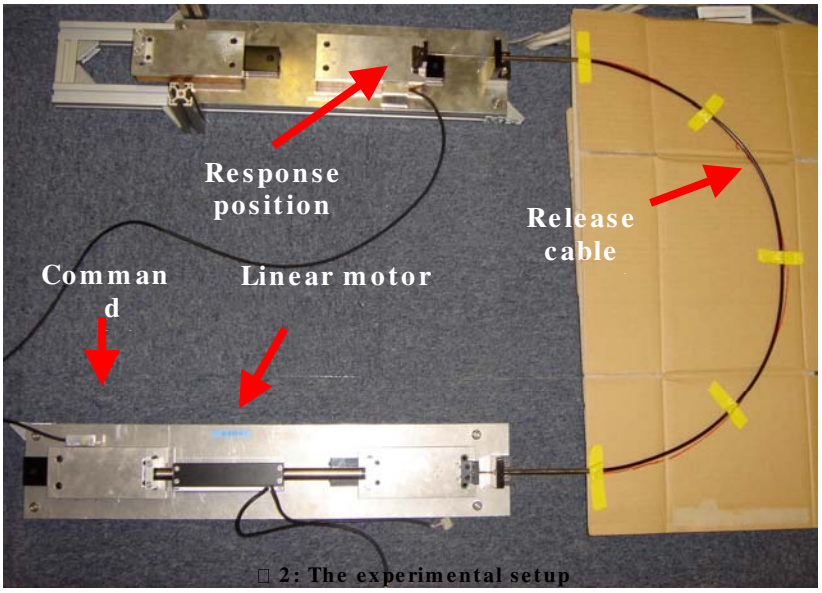
The second kind of research I did at the lab was assigned to me by my professor and involved studying properties of release cables. Bilateral Control basically consists of a master and slave system. These are 'connected' electronically using a real-time processing unit (whether it be a dedicated machine or a program running on a real-time operating system). However, these master and slave systems also have to interact with the environment. In order to allow miniaturization, this has to be done in a as flexible way as possible and can be solved by using 'release cables'. This allows the master/slave system to be in a different location than the interaction with the environment. Release cables also have the advantage that the master/slave system can be fixed, while the location and rotation of the interaction with the environment changes.
It turns out, however, that the release cables do not behave in a linear fashion. A movement at one

side does not necessarily result in an identical movement on the other side. Various phenomena are present that result in this non-linearity. Because of the way the connections of the release are engineered, there is a certain amount of backlash present. The means that as the master starts moving, the slave is still at a standstill until the backlash is overcome. This is a common problem in the field of mechatronics and is due to some friction present in the cable system. Another phenomenon that is observed is that of compliance of the release cable. As the acceleration of movement is increased, the compliance effects become evident and turn out to be different for push and pull actions. When combining these two phenomena, a complicated non-linear behavior exists.
My task was to perform experiments to observe the non-linearity and identify it. This was done by exciting the release cable with a sinusoid of varying frequency using a linear motor. By repeating this experiment at several frequencies (0.2 Hz to 60 Hz), a frequency response can be created. However, more important for analyzing the non-linearity is by comparing the position vs. time graphs for both the driving position and driven position. At low frequencies, the acceleration is low and compliance effects are negligible. Under these circumstances, the back-lash effect is observed and can be quantified (such as in picture 1 above). As the frequency is increased, the compliance of the release cable is observed and the different properties for push and pull actions is visible. This experiment was repeated for different cable setups, which had an effect on the friction inside the release cable. The most notable difference between the different setups was the amount of backlash. As the curvature radius of the bended release cable increased, the backlash also increased.



1: The effects of Backlash when bending the release cable

Having done these experiments, I gained a better understanding of the complicated issues that arise when working with dynamic systems. Since I might incorporate a release-cable system in my master thesis, this experiment certainly will aid me in the future.



2: The experimental setup

5. Student life

Keio University provided me with accommodations and the location was extremely good. I was placed at Hiyoshi International House. This building, owned and operated by the university, is an 8 minute walk from the Engineering campus and 10 minutes from the subway station. Within half an hour, students can make it from the dormitory to Shibuya, the hub of Tokyo. The dormitory was very well organized and clean. I shared common facilities, such as shower, bath, kitchen and toilet, with a roommate. The room, on the other hand, is private and spacious to Tokyo standards. Technology was also of high quality, as we were provided with microwave oven, super fast internet connection, telephone and air-conditioner at no cost. Additionally, the international center financially supported DeMaMech students in paying for the rental cost of the dormitory.

Since all the students at the HIH are international students, it is very easy to get in touch and communicate with them. They are all comfortable with speaking English and are very open minded. From time to time, get-together parties and farewell parties were organized in the common lounge and were a great way to learn about other countries and meet new people. However, I found this sometimes a little too international and tried to integrate with the Japanese people as much as possible. This way I would learn as much as possible from the culture and the often misunderstood Japanese way of living. I came in contact with Japanese people in two ways: by working at my laboratory and by joining the Keio Freestyle Windsurfing Circle, BLAST.

At my laboratory, the students were extremely helpful and friendly (just as in any other place in Japan) and, except the Japanese students, there were also some international students present. Lab life takes up most of the time for Japanese students. Everything is done at the lab: sleeping if a paper deadline is creeping up, eating, studying and just plain chatting about life. This makes for a very informal setting and was ideal for me to observe the Japanese way of living. Compared to other labs, my lab was very studious and only one welcome party was organized. This made it a little duller, but it did allow for a productive time at the lab. Particularly interesting was the mutual respect students have for each other and the respect that goes out to senior members. As an international student, I was mainly exempt from these informalities, but did try to adhere to them as much as possible. In the beginning, I made several mistakes with trying to communicate, but as time passed and I saw how it was properly done I was able to improve. I am proud to say that I now know how to adhere to the Japanese unwritten rules of public behavior and interaction with other people.

I also joined BLAST, the Keio University Freestyle Windsurfing Circle. A circle is a group of students interested in the same hobby, who have the support of the University but are not obliged to be present each time there is a meeting. My circle was supported by an economics professor with a passion for windsurfing. During the weekends, I would wake up early and catch a train to Zushi, where the clubhouse is located. This trip took one hour each way, but was certainly worth it. The circle kept its material at a surf club at Zushi, a nice beach well known with Tokyoites. Something typically Japanese is the fact that the circle students simple shared their private material with other members. I was always able to use windsurfing material at no charge from other members!

At the club, I also met lots of Japanese people that were not a student. Since I otherwise only come into contact with Japanese students, this was an ideal way to get in touch with Japanese with other mindsets. In general, the language skills were of low proficiency level, but I was able to communicate without much problems. Not only did I improve my Freestyle Windsurfing skills, I learned a lot from interacting with Japanese windsurfing people and had great fun doing it!

6. Summary

I left Japan only with positive memories. In the past, I have lived abroad and nothing compares to the hospitality and friendliness of the Japanese people. Although I was unable to learn the language in such a short time, I was able to learn Katakana (a special alphabet used to name western items and most food/drinks). At the lab, I gained a general understanding of Bilateral Control, but actually more importantly, I gained insight in the Japanese daily life and student life. The students were extremely supporting and interested in my experience coming from Europe. I hope I was also able to teach them some new things.

The contrast between Belgium and Japan was big, but this allowed me to fully grasp the differences between the two countries. There were things that I love about Japan and look down upon in Belgium, but there were also aspects of the Japanese culture that I could not agree with. I came back to Belgium with an added appreciation for both countries. Unfortunately, I have left many good friends in Japan, but I hope to see them again soon. The DeMaMech program has given me the opportunity to discover yet another unseen part of the world and my experience will certainly be a great benefit for my further career and personal life.

I would like to thank my supervising professors in Belgium and my supervising professor at Keio. They enabled me to academically grow to the maximum extent. My thanks also go out to the DeMaMech program, which streamlined the whole process of moving from Belgium to Japan. It would have been a whole lot harder without the practical and financial help of the program. Lastly, I would like to thank all my Japanese friends, both from Keio, windsurfing circle, as well as outside of school, who have tried their hardest to help me integrate and teach me the Japanese way of living. I look back at my Japan with great nostalgia and hope to be back soon...