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工系3学院学生国際交流基金プログラム

帰国報告書

Debrief Report of International Exchange Program operated by Engineering Schools

派遣者氏名 Your Name: Yopi Prabowo Oktiovan	
所属・研究室・学年 Affiation and Grade: Architecture and Building Engineering	
派遣先大学・専攻 Name of Host Institute/ Dept.: RWTH Aachen University 受入研究室・教員名 Name of Host Laboratory/ Supervisor: Professor Sven Klinkel	
派遣期間 Period of Study Abroad: 30年06月01日 ～30年09月09日	
申請カテゴリーCategory: ☒(C1)SERP ☐(C2)AOTULE ☐(C3-a)部局間協定校 ☐(C3-b)全学協定校 ☐(C4)その他	
研究(プロジェクト)題目Research Theme : The application of Scaled Boundary Isogeometric Analysis on Hyperelastic Material model	

注意 Notes:

A) 帰国後1か月以内に工系国際連携室宛(ko.intl@jim.titech.ac.jp)に**MS Word**ファイルにて提出ください。Please submit the report in Word file within 1 month after returning to Japan.
B) SERP・AOTULEで派遣された場合は、受入教員の評価書も添付して下さい。Please attach the Evaluation Report written by your host supervisor.
C) この表紙を含まず、ページ数は2～4ページ、ファイルサイズは3MB以内としてください。The report has to be 2~4 pages without containing these two cover pages and within 3 MB.
D) 研究室や宿舎内の様子の写真、図表、イラスト、滞在中のその他の写真などは挿入可です。ただし、それらを掲載する際には簡単な説明を加えて下さい。Please insert pictures and charts with captions.
E) 提出された報告書を工系のホームページに掲載いたします。また、別途、学内広報誌「東工大クロニクル」の執筆をお願いすることがあります。The report will be posted in the Engineering Schools' website. You may also be requested to contribute a report to Tokyo Tech Chronicle.

報告書必須記載事項

1. 派遣大学の概要(所在地、創立年、規模など) Outline of your host university (Location, Time of Founding, Scale of the university)
2. 留学準備など Preparations before your study abroad
3. 所属研究室での研究概要とその経過や成果、課題など Outline of your research and its progress, finding, and challenges for the future
4. 所属研究室内外の活動・体験(日常生活・余暇に行った事など) Activities and experiences beside research (daily life/ leisure)
5. 留学先での住居(寮、ホームステイ等)、申し込み方法、ルームメイトなど Type of Accomodation (dorm/ homestay) and its application method, who were your roommates and etc.
6. 留学費用(渡航費、生活費、住居費、保険料)など Expenses (Flights, Livng cost, Housing/Rooming rent, Premium, Administrative fees, and etc.)
7. 今回の留学から得られたもの、後輩へのメッセージ、感想、意見、要望 Outcomes through the study abroad, Message to juniors, Feedbacks, Opinions, or Requests
8. その他 *任意 Other *optional (Trouble, Your Career Path, etc)
(留学先で困ったこと、帰国後の進路(就職・進学・長期留学)など)

東京工業大学　工系3学院学生国際交流基金

帰国報告書

派遣年月 **Period of Study Abroad：30年06月~09月**

氏　　名 **Name：Yopi Prabowo Oktiovan**

所　　属 **Affiliation at Tokyo Tech：School of Environment and Society, Dept. of Architecture and Building Engineering**

派 遣 先 **Host University：RWTH Aachen University**

（次ページ以降に記入してください。）

RWTH Aachen University stands for *Rheinisch-Westfälische Technische Hochschule* Aachen (Rhine-Westphalia Technical Institute). RWTH Aachen is a research university located in Aachen, North Rhine-Westphalia, Germany. Having more than 42,000 students currently enrolled in a total of 144 study programs, it is considered as the largest technical university in Germany.

RWTH Aachen was founded in 10th October 1870 when prince Frederick William of Prussia (later German Emperor) was given a donation of 5,000 talers (silver coin, a currency before German unification) from *Aachener und Münchener Feuer-Versicherungs-Gesellschaft* (precursor to Aachen-Munchen Insurance Company) for charity. The prince decided to use the donation to found the very foundation of RWTH Aachen University.

For the university scale, RWTH Aachen was chosen as one of nine German Univesities of Excellence, earning its connotation of being an elite university. Nationally, RWTH Aachen is the best university in German in fields of engineering (especially mechanical engineering, chemical engineering, and electrical engineering). The QS World University Rankings ranked RWTH Aachen 12th in the world in mechanical engineering.

In order to conduct your research as an exchange student in Germany, if the exchange student holds a Japanese Passport, the person can stay in Germany for up to 90 days. If the stay is more than 90 days, the person is obligated to apply for a *Schengen* Visa. This visa is valid throughout the whole *European Union* (EU). The application process is easier if the student had obtained a letter of acceptance from RWTH Aachen as the Visa type will be categorized as *Wissenschaftlicher* (Research Assistant). The process fee will also be waived if the student obtained funding from RWTH Aachen University (i.e. through the Germany-Japan Research Fellowship).

The research topic that I conducted on RWTH Aachen is the Scaled Boundary Isogeometric Analysis. In general, Isogeometric Analysis is the novel finite element method that utilizes the flexibility of NURBS (*Non-Uniform Rational B-Spline*) control points as "nodes" in the finite element realm. This has proven to speed up the analysis process up to 70% compared to conventional Finite Element Method. Moreover, the Isogeometric Analysis was able to capture better interpretation of the geometry in question compared to FEM, i.e. in reading curved geometry, as NURBS control points were able to map the curved geometry precisely whereas the nodes in FEM were only able to interpolate the sections in curved geometry, producing a somewhat underestimated results. The Scaled-Boundary Isogeometric Analysis (SB-IGA) follows the idea of the scaled boundary finite element method, where solids are parameterized by a radial scaling parameter that emanates from a calculated scaling center and a parameter in the circumferential direction along the boundary. This fits perfectly

with the surface-oriented modelling of solids in CAD, where NURBS basis functions are used in CAD in order to describe the boundary of solids. The same NURBS were also used to approximate the displacements according to IGA. Therefore, there are no loss in translations from design to analysis steps, which means the geometry remains *exact* throughout the whole process. This method is employed using a simple hyperelastic material model called the St. Venant-Kirchhoff material model on my research topic. The SB-IGA method is shown in Figure 1.

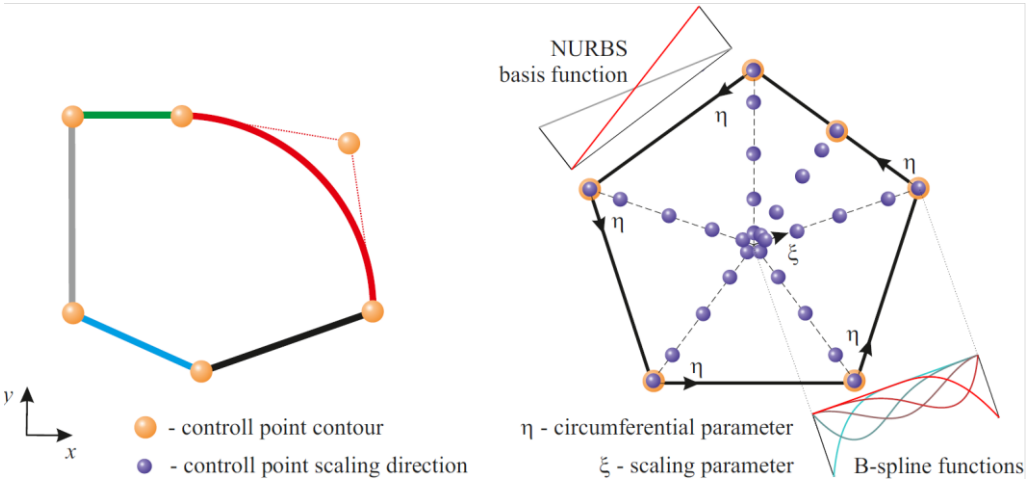


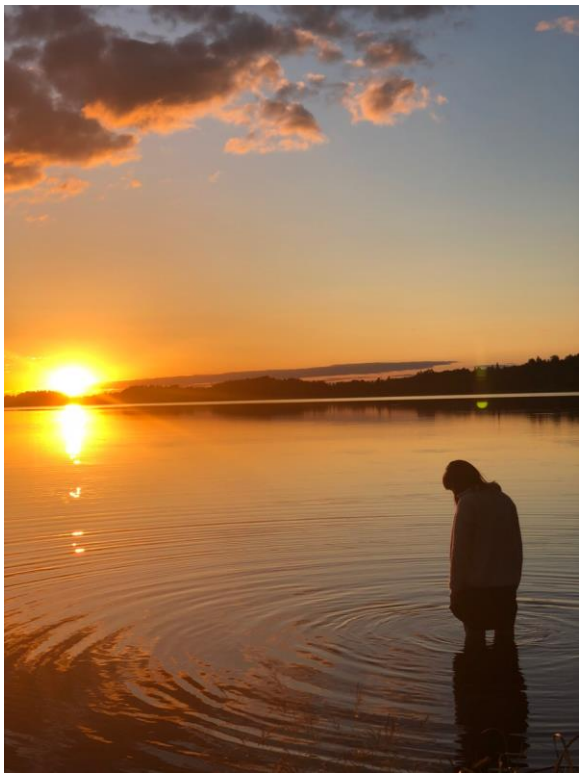
Figure 1 Scaled-Boundary Isogeometric Analysis Parameterization

The time outside of research work was spent on observing the city of Aachen, travelling to various cities like Amsterdam, Helsinki, Oslo, Koln, Dusseldorf, and Brussels. Since I have arrived in Germany using *Schengen* Visa, I was able to visit various countries outside Germany easily. Some of the pictures were shown from Figure 2 and Figure 3.

(a)

(b)

Figure 2 (a) and (b) Famous Church in Koln



(a)

(b)

Figure 3 Picture from Travelling in Helsinki, Finland

As for my accommodation during my stay in RWTH Aachen, I have asked for some help from the Indonesian Student Association in Aachen since the accommodation provided from the university is fully booked by the time I arrived at Aachen. The accommodation in Germany was divided into numerous categories, such as WG (*Wohngemeinschaft*, Shared Accommodation), *Einzelzimmer* (One Bedroom Apartment), *Schlafsaal* (Dormitory), and etc. My accommodation was a WG with monthly rent of €240/month. This is just a rent fee, excluding the electricity, water, and gas fee. My roommates were all Indonesian with different reasons on coming to Aachen. Some of them were students at *Fachschule* Aachen, another university in Aachen.

The expenses in Germany was relatively similar to those in Japan. For a monthly stipendium of €1000, I spent €240 on rent, roughly €300 on foods (cooking instead of eating out). As for the transportation fee, it was covered by the student service in RWTH Aachen in form of Student Service fee (around €280). By paying Student Service fee, I received a Semesterticket card which was valid throughout the whole North Rhine-Westphalia (free travel on bus, tram, and trains).

My message for the next students is to be prepared to learn Germany before departing to Aachen as most of the elders and staff workers do not speak English. Try to learn a couple German words and conversations in order to catch up with the other PhD students and Master students. Also, be prepared to drink a lot of beer as it is truly cheaper than water.