Host Institute:

Höchstleistungsrechenzentrum
High-Performance Computing Centre

Home University:

Massachusetts Institute of Technology

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Research at HLRS

My first impression upon arriving at HLRS was a feeling of being in an art exhibit (in one of those modern art museums). The building was very new and its design very minimalist. Many sections of the walls were glass, and many of the stairways were white or grey and surrounded by white or grey or glass walls, so that they felt very open. Even months later, towards the end of my internship, I was often struck by the feeling of being in an art exhibit when I walked up and down those stairs. The hallways were painted in eye-popping shades of blue or pink; every day of work I walked down a pink hallway several times to the lab.

One of the rooms in HLRS was called the Cave, and it contained a VR setup resembling a cube minus one horizontal face. It could fit many people, each wearing special 3D glasses. Behind each of the floor, ceiling, and the three horizontal walls was a projector that projected images synced to the glasses worn by one user, and it tracked where the person was looking so that the projections adjusted as the person moved and looked around, creating a very immersive experience. With a remote one could enlarge these images, turn them to look at a different side, and move them around. One of the projects that used this VR setup was a driving simulator, and this summer I worked in the Visualisation department under Dr. Uwe Wössner, on one aspect of the driving simulator project.

The group would drive around the streets with a 3D laser scanner, and then match the scanned data with the location of the car at the point where each particular set of data was obtained. But because the positions of the car as obtained from GPS were not accurate enough, someone had to manually correct for the offset. I worked on improving the localization of the car using differential GPS, in which two GPS receivers are used. One acts as a fixed base station whose position is accurately known, and sends data to the other receiver (the rover) to allow the rover to correct its own measurements. The goal was to obtain an accuracy of ±20cm, and in the end I achieved an accuracy of ±50cm.

Early in the project I used skills I had learnt in my electronics classes and my research project at MIT last semester to figure out and solder connections for the GPS receivers. I used an open-source program package called RTKLIB to set up differential GPS with the two receivers, and a large part of the project involved experimental work to determine optimal settings for each receiver.

← Experimental set-up, with data streams from two GPS receivers (circled in red)
RTKLIB allows one to see the number and type of satellites each receiver is able to get data from, as well as the messages each receiver is sending to the computer and error messages. Settings on the receivers and options for data correction can also be configured, and my experimental work involved trying out different combinations of settings on the two receivers, walking in a rectangular path with distances I had measured before with one receiver (the rover), and comparing how accurately my path was traced out by RTKLIB.

RTKLIB provides a graphical user interface on Windows. (Orange) Positions of satellites as seen by each of the rover and base receivers; (blue) messages from rover and base; (green) error messages; (purple) plot of position of rover, where each grid is 1m x 1m

Example of a path I planned out and the resulting plot
I did the experimental work on a large patch of grass next to HLRS, close enough to the building to stay connected to the Wi-Fi but far enough that the receivers would not receive too many radio waves from the satellites that had reflected off the building. I stacked stones every 1 to 2 metres to mark out my path, as well as for some of the tests where I would set the GPS receiver down at these 1- to 2-metre intervals for certain durations (1 minute, 30 seconds, 15 seconds) to see how that particular configuration of settings responded to stops in the otherwise continuous movement of the rover. There was a week or so where I stopped testing in the field, which also happened to be a very rainy week, and when I returned I couldn’t find the stacked stones anymore because the grass had sprung up around them and completely swallowed them.

While out in the field (literally), I was approached no less than six times and asked in German what I was doing. I would apologetically ask if I could explain the project in English instead of in my limited German (which worked out all times except once, and I was sorry I couldn’t give that person a better explanation). Some of the people who approached me worked at HLRS, and one of them worked in a company that had rented space in the building beside HLRS. His company dealt with the shipping industry, and coincidentally one of the things they were working on was getting accurate readings of the position of the ship, while minimizing the cost associated with the GPS receivers. They had often seen me on the fields and had taken guesses as to what I doing. (Indeed I thought, on more than one occasion, that I must look like I was performing some sort of ritual. Someone also wondered if I was counting the plants in the field.)

Currently both GPS receivers are tethered to the same laptop. Future steps will involve separating the two GPS receivers and having messages be transmitted across an Internet connection. The rover, which should be easy to transport around with the car, will be connected to a Raspberry Pi, which should send startup commands and optimal configuration settings to the receiver.

**Work Culture at HLRS**

My work on improving the accuracy of localisation by GPS reminded me of the research project that I had been working on the previous semester at MIT. A major difference was that at HLRS I got to see what the other people in the group were working in: for example, another student in the SUPER program, a master’s student in the lab, and I were all working on the driving simulator, albeit different aspects of the project, and we had ample opportunity to discuss what exactly our contribution was. We also learnt about the other projects in the department, such as the visualisation of airflow around a car or a building. I got to try out a paragliding simulation in *the Cave*, took my first steps at learning to drive on the driving simulator, and floated (that was what it felt like) around reconstructions of...
ancient structures at an archaeological site in Greece. So I could better see how my part fit into the big picture, while in my research at MIT I had less time to learn about the other areas of the project.

I’ve found that work culture may depend more on the industry than on the country you’re in. I was expecting stricter requirements on punctuality and work hours, but probably because I was in academia I experienced a lot of flexibility.

The interesting signs around the workplace provided me little amusements every day, from some oddly specific ones to others that made me worry about what had happened before.

My supervisor planned a bunch of activities among us and the rest of the department, including a barbecue (right) and a traditional Bavarian breakfast, at which I learnt how to properly pour beer.

Discovering German Culture and Stuttgart’s Surprises
The first thing that struck me about Stuttgart was the diversity. Perhaps because there were so many university students, it was more diverse than I’d expected, and people would often
speak to me in German instead of English, which I really appreciated. As an international student at MIT I had thought that I was already sufficiently immersed in the overseas experience, but working abroad afforded me more time and opportunity to interact with a truly diverse group of people.

Not only were the other students in the SUPER program from varied backgrounds, but the dorm I (and most of the SUPER students) stayed at was also very international and the tenants rotated often; as a result I met students in the ERASMUS program and two other groups on three-week programs. We had long conversations on both serious and trivial issues, and I am truly grateful for how much I’ve learnt and grown from them.← View from the rooftop of our dorm

The International Student Hotel at Neckarstraße 172 comprises three interconnected buildings with different layouts of rooms and kitchen spaces. My room

It was hard to miss how infrequently one saw German flags, and it was enlightening to learn about the attitudes of Germans towards nationalism. I had great conversations about current issues, most prominently immigration. On a more light-hearted note I also found out about the rivalry between the eastern and western parts of Germany, and the very interesting perception that the rest of Germany has of Bavaria. And through my own travels and events like a birthday party I learnt things like how to indicate how much tip I wanted to leave, and useful (drinking) phrases that I did not learn from my German classes at MIT.

Sustainability efforts in Germany and in many other parts of Europe left a strong impression on me, although I must admit I still do not know how to properly sort my trash. Sorting one’s trash into the correct recycling category is very ingrained in the mindset and lifestyle in Germany. The recycling at MIT is single-stream, and while the convenience may encourage people to recycle more, I feel like the ease cultivates a more cavalier attitude towards recycling, while sustainable habits seem to have been built into the culture in Germany (and, it seems, many other countries in Europe). My Italian flat-mate instinctively switched off the lights whenever he left a room. I was accustomed to leaving the hallway lights on if I thought I would pass through again in a short time, but I would often find them switched off.
I was surprised by how much Stuttgart grew on me during my time there. The abundant greenery and the S-Bahn stations reminded me a lot of my hometown Singapore, and the nightlife really surprised me.

Taken from an overhead bridge that connects the dorm to a park, this really resembles roads in Singapore.

**Personal Growth**

Through solo travels every other weekend I’ve grown confident enough to rely on myself in a foreign place, and to be comfortable with solitude. After my time in Germany I’ve also realized how much it matters to me that I should know at least one foreign language— not just be able to read and write it, but more importantly to be able to converse fluently in it. Even after four semesters of German classes at MIT I was not fluent enough to go about my daily business in German. For official tasks like getting a student pass for the public transport, checking out of my room, or closing my bank account, I often wasn’t confident enough to do the transaction in German, or I would start in German but have to switch to English because I could not follow the replies. There were also situations that required me to be quick (such as when ordering something in a line), which stressed me out so that such things like grammar and sentence structure wouldn’t come naturally to the front of my mind. The bigger challenge was definitely making a conscious effort to speak German when it was so easy to just fall back on English since so many people in Germany could speak English so well. It definitely made me reflect on the way I’d learned German and think about how I could improve my study technique.

View from the Berlin Cathedral— it was while I was standing up here that I decided I wanted to live for some time in Berlin.

At MIT, students refer to the “MIT bubble”, where one has spent too long living, studying, and doing everything on campus. The remedy is to go off campus, perhaps venture into Boston for a bit. I certainly feel like I’ve broken out of the MIT bubble this summer, from living and working with people from other universities and countries and having conversations with them that are very different from the topics I usually talk about with my
friends back at MIT. I am once again reminded to pay attention to the exciting innovations happening in other countries, and to keep a broader perspective of the world.

To Future SUPER Participants

1. If you’re doing the SUPER program at the University of Stuttgart, talk to people who’ve worked at the specific institutes you’re considering. Your internship experience will depend heavily on the institute you’re working at.

2. In a similar vein, ask people who’ve lived at the dorm you’ll be living in, or worked at the institute you’ll be working in, etc. for things they wished they’d known before going there. Specific advice from people who’ve been in your shoes would be extremely helpful.

3. Make a schedule of goals to accomplish at your workplace, a sort of timeline of the progress you should make every week, because time runs out far quicker than you realize.

4. Talk to the people where you live and at your workplace. One of the things I regret the most was not trying earlier to get to know my apartment-mates and co-workers, especially since they came from such a different backgrounds than I did. I’m not sure how to balance spending time with the people here and trying to get as much work done as you can during your time here; that’ll be something for you to figure out. 😊

5. Enjoy Stuttgart!