STSI 2021 - Team Member Program

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Research Internship:

I had the privilege to intern at the Laboratory of Biomechanical Design under the supervision of Prof. Masahiro Todoh. I worked on the computational modelling and analysis of the human wrist joint with Prahasith Maddury, a master's student at the Laboratory.

Aim:

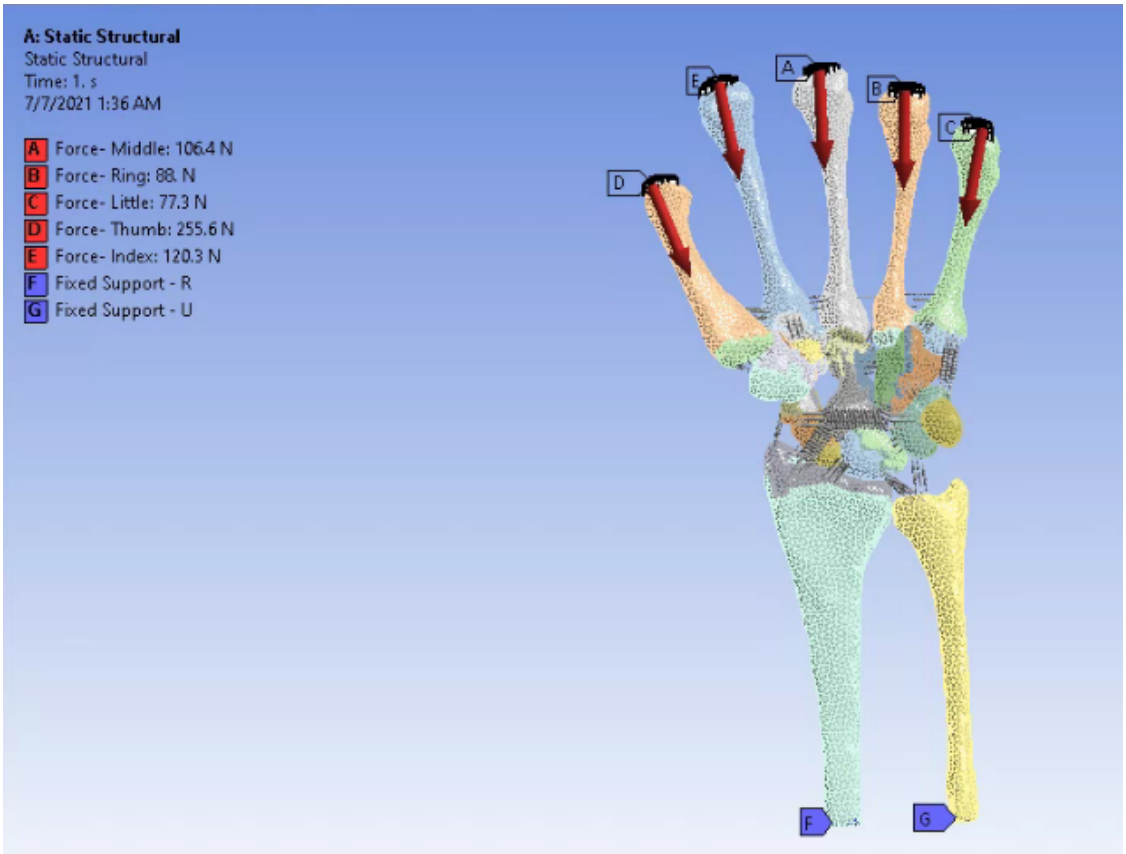
The main aim of my project was to model the human wrist joint as close to reality as possible to enable a Finite Element Analysis. Although several other simpler joints like that of the knee, shoulder and hip have been simulated using FEA before, the complex joints like the wrist and the ankle haven't been modelled satisfactorily to match their physical behaviour.

Work done:

Using several softwares including the Materialise Innovation Suite (consisting of Mimics and 3-matic), and Ansys Workbench (SpaceClaim and Mechanical), I modelled the bones, cartilages and ligaments of the wrist.

I performed image segmentation on MRI slices to create masks for the bones. These masks were then used to generate 3D parts which resembled the shape of the bones. After cleaning the scatter caused due to imaging artifacts and smoothening the parts to remove rough

edges, the bones were meshed using 4 noded tetrahedral elements. Next, I worked to create cartilages by creating offset copies of the bones and subtracting them from the original bones. Then, I used nonlinear node-to-node springs in parallel to model the ligaments. We decided to study the action of gripping. To model this, I applied fixed supports at the distal ends of the radius and ulna and compressive loads along the axes of the metacarpals on certain nodes at the proximal tips to prevent untoward stress concentrations.



Further work:

The model will be ready to run once material properties (cancellous and cortical for the bones, nonlinear for the ligaments) are assigned and the contacts between the articulating surfaces are defined. Once we have a working model, it can be used either in static or dynamic modes to study a variety of problems ranging from prosthetic design to the progression of diseases.

STSI Experience:

Courses:

I took two courses- one on Japanese Language and Culture and the other on STSI Fundamentals.

Fundamentals of Japanese Language and Culture:

Although the pandemic depriving us of our opportunity to experience the beauty of Sapporo and Japan first hand stung me a fair bit, this course did a good job of soothing some of my pain. Apart from picking up the basics of the Japanese language (I can hopefully survive if I get lost in Japan), I had the pleasure of interacting with the Japanese and learning about their culture and way of living. I am sure the in-person experience would have been a whole different adventure, but the STSI staff did their best to give us a taste of Japan

through this course. Nishiya Sensei is the sweetest and the most patient language teacher I've had the pleasure of learning from.

STSI Fundamentals:

The course started with a week-long PBL (Project Based Learning) in which we were split into groups that were a mix of Indian and Japanese students. My team was assigned the challenging task of coming up with an innovative and futuristic solution to one of the problems facing the transportation and infrastructure systems in Japan and India. Right from the problem definition stage and all the way to the final ideation stage, Fujita Sensei, Okazaki Sensei, and Ravankar Sensei were incredibly helpful. Their inputs at each stage nudged us in the right direction and ensured fruitful discussions during each of the sessions. I had a great time working with my team and learning from them, and I am proud of the work we produced in such a short time.

Following the PBL, we had a series of omnibus lectures. Professors from IIT Bombay, IIT Madras, IIT Hyderabad, and Hokkaido University gave us insights into various topics like communication, bridges, public policies, etc., which influence the transportation and infrastructure in both Japan and India. These lectures were very informative and gave us a global perspective of the topics.

Overall experience:

I am incredibly pleased with my STSI experience. When I had applied to the program last November, I was not sure about my decision. But the last month was the most lively, interactive, and proactive month I have had in a long time, and the pleasure of experiencing a different culture, especially one as vibrant and kind as the Japanese, all amid a global pandemic, proved all my initial inhibitions wrong.

Acknowledgements:

Firstly, I am immensely grateful to Todoh Sensei, who welcomed me into his lab with immense warmth and allowed me to pursue my interest in biomechanics, coupled with my computational skills and interests. I owe much of my internship experience to Prahasith-san, an IITH Alumnus and a masters student at the Laboratory of Biomechanical Design. It was under his tutelage that I performed all of my modeling, and I could not have asked for a better tutor.

I would like to thank the STSI program and staff, Hokkaido University, Dr. Ashok Kumar Pandey, and IIT Hyderabad for giving me this wonderful opportunity.