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Human Interface

from Keio's Faculty of Science and Technology

Bridging humans and computers

Yuta Sugiura

Associate Professor
Department of Information and Computer Science

Developing Trustworthy and User-friendly Human Interfaces

Incorporating Computers into Our Daily Lives

The "human interface" connecting humans and computers has become an essential part of our everyday lives. Associate Professor Sugiura from the Department of Information and Computer Science is developing systems that add human interface features to our familiar soft objects such as cushions and stuffed toys to seamlessly integrate interfaces into our daily lives and assist us. The potential research applications span across various domains, including child-rearing, orchestral performances, and disease detection.

The softest interface ever

As its name implies, the term "human interface" denotes the touchpoint where humans and computers interact and exchange information. Common examples include the mouse and keyboard of computers, and smartphone touchscreens. In recent years, as computers have become more compact and telecommunication has become faster, the potential and roles of human interface has expanded immensely.

Against this backdrop, what caught Sugiura's attention were the "soft" objects in our everyday lives, and his research has been focusing on the integration of human interfaces into unexpected items.

As Sugiura explains, "We are surrounded by soft objects such as sofas, cushions, stuffed toys (Fig. 1), sheets, curtains, and numerous others in our daily routines. We are exploring various technologies and systems based on the idea of adding human interface functions to these kinds of items, enabling the smooth measurement of human behavior and the transfer of information from computers to individuals, with no conscious operation necessary."

Practice holding babies with stuffed animals and cushions

Along with developing fundamental technologies in human interface, Sugiura's laboratory is also conducting unique research projects in collaboration with experts in diverse fields.

One example is a smartphone app designed to instruct people on how to hold babies. It works by attaching a smartphone with this app to a stuffed animal or cushion. Then, the user simulates holding a baby with the object, and the app provides feedback to guide the user on how to hold one properly (Fig. 2) .

Being a father himself, Sugiura had a personal experience where he struggled to hold his newborn who had yet to develop the necessary head support. As he puts it, "I felt it would be helpful to have some training before a baby is born to know the right way of holding them. At that time, I was approached by Associate Professor Noriko Aso from Kanagawa University, who had experience as a midwife and is currently conducting research in clinical psychology. She broached the possibility of a joint research project. As infants who aren't held properly may cry incessantly, contributing to additional parental stress, and in some severe cases, even leading to abuse. We hope that the tools we have developed will help make parenting a little easier."

Performance in an orchestra with visually impaired musicians

Sugiura's research is not limited to his experiences with child-rearing, but also encompasses his hobbies and interests. Since childhood, Sugiura has been playing the violin and he joined an orchestra while he was a student. He states, "It was my dream to someday be in a performance with visually impaired musicians." The unique challenge faced by visually impaired musicians is that

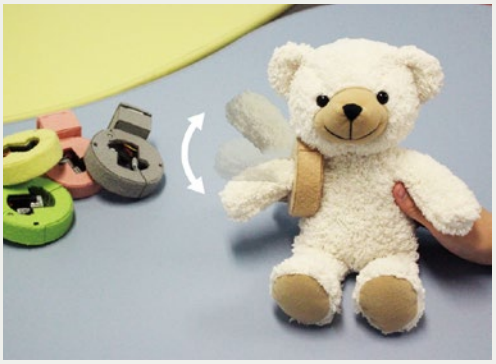


Fig.1 Device used to move a stuffed animal's limbs
By attaching this motorized ring-shaped device to a stuffed animal toy, human can make its arms, legs, and tail move. Conversely, if the device is equipped inside the toy, it necessitates cutting it open to install or remove the device, and moreover, the toy would lose its softness. Sugiura sought a way to allow familiar stuffed toys to become operable as if they were robots wearing accessories, while maintaining their original softness.

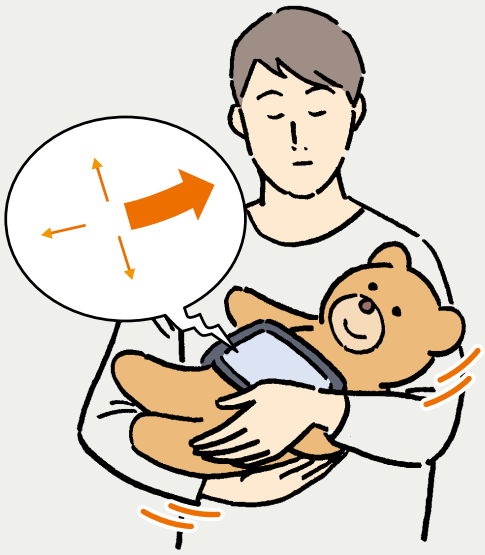


Fig.2 App used to practice holding a baby
When a stuffed animal is equipped with a smartphone using this application and used for practice, the smartphone's built-in sensor detects the baby's (stuffed animal's) body position, and the smartphone's screen guide the users with messages such as "Tilt the baby's body more toward your chest," following the predetermined method established by the midwife. This approach utilizes technology that senses soft objects.

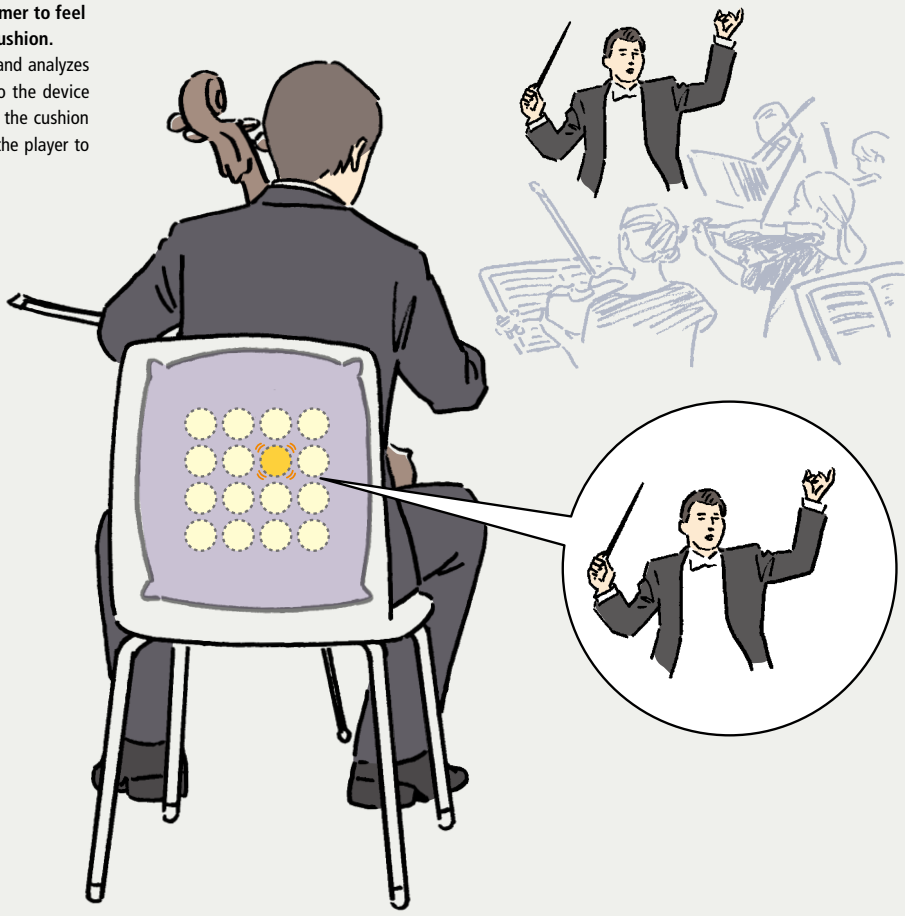


Fig.3 System allowing a visually impaired music performer to feel the conductor's gestures on their back through a soft cushion.
A dedicated camera with motion capture systems captures and analyzes the conductor's baton, which is transmitted in real time to the device in the cushion behind the player's back. Since the device in the cushion vibrates in accordance with conductor's gestures, allowing the player to physically feel the motion of the baton on their back.

they cannot see the conductor's gestures, which makes it difficult for them to follow the tempo and express the music appropriately. To solve this problem, Sugiura developed a device that transmits the conductor's gestures to a soft cushion attached to the backrest of a performer's seat, which captures the movements of the conductor's baton and vibrates in response, allowing the performer to feel the instruction (Fig. 3) .

Indeed, one visually impaired horn player who tested the device had a positive reaction, stating, "I usually rely on the breathing sound of the people around me when performing, but using this tool made it easier to synchronize with the tempo." As a result, as an open experiment, we collaborated with them to successfully hold a concert at the Yagami campus in December 2023.

Simply play games, and detect potential diseases

In addition to the above applications, Sugiura has also been collaborating with medical researchers to develop tools for detecting early signs of medical conditions (Fig. 4) . One example is carpal tunnel syndrome, which causes numbness and pain in the fingers due to aging and overuse of the hands. Early detection and treatment are important because it may require surgery when it progresses to a later stage.

To address this, Sugiura developed a smartphone app that can assess whether an individual has carpal tunnel syndrome simply by engaging them in a game. As the condition progresses, carpal tunnel syndrome is characterized by the individual having difficulty moving their thumb. The game app collects data on an individual's thumb movements as they play the game and uses machine learning models to estimate the likelihood of them having carpal tunnel syndrome. If the app determines a high possibility of the condition, it will display a message urging them to go to a hospital.

Sugiura's future goal is to design an app that can estimate the possibility of having a medical condition by collecting and analyzing data on movements made through daily smartphone activities such as typing with flick input, and other gestures. In addition to smartphones, it may also be possible to detect abnormalities in their walking patterns by attaching a device to their slippers to observe and analyze their gait, which could be applied at places such as senior support centers.

Sugiura has ambitious plans for expanding theses kinds of projects. He emphasizes the importance of not ignoring seemingly non-life-threatening issues, since those signs could lead to a cycle of worsening health, including repeated falls, fractures, and muscle weakness. As he notes, "If we can detect abnormalities and encourage people to seek medical attention through devices that naturally blend into their daily lives, it is possible to treat the illness before their conditions worsen." Sugiura also envisions developing devices that monitor not only people's physical movements, but also their emotions and feelings. For example, when you are feeling down and you sit on a sofa, there could be a device that detects how you feel and respond by playing music to cheer you up. As he says, "I hope to create a future where computers like these seamlessly support our daily lives without us consciously realizing their presence." With Sugiura's research closely linked to various aspects of our everyday lives, what will be next? We are excited to see what he has in store for us in the future.

(Interview and text writer: Chisato Hata)

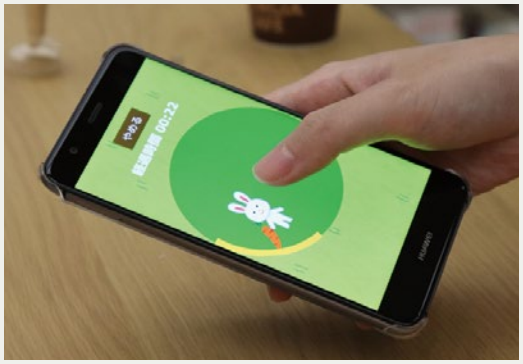


Fig.4 Smartphone game that detects the onset of carpal tunnel syndrome
This app is a game where users move a rabbit with their thumb to pick up food that appears on screen. The app monitors the thumb's movement, and estimated whether the user has carpal tunnel syndrome. Testing confirmed that the condition could be diagnosed with the same or greater accuracy as in-person findings conducted by a specialist physician. This app was developed in collaboration with Professor Koji Fujita of the Tokyo Medical and Dental University.

Everyday life is a treasure trove of research ideas waiting to be discovered

Inspired by his father, Sugiura's childhood hobbies of building plastic models and robots set him on the path towards researching about human interface. By identifying issues revealed by everyday experiences, he comes up with a string of innovative ideas. The secret behind the birth of all these ideas lies in the promotion of a research environment that values communication.

What was your family environment like growing up?

I am the oldest of five siblings. My mother worked as an elementary school teacher, and my father was self-employed, specializing in designing various machines. My father had a keen interest in building things as a hobby, and often be found to be building things in the living room during his spare time. It was not uncommon to find tools lying scattered around the floor, our house was filled with large automatic machinery. Growing up in such an environment naturally drew me towards pursuing a career in building and creating things. When I was in elementary school and junior high school, I was really into model kits, mini four-wheel drive cars, and remote-controlled vehicles. The remote-controlled (RC) toys were the real deal. I would make them by cutting out the materials from wood myself and soldering on the motors. I built cars, ships, planes and conquered land, sea, and air with them.

In high school, I made bipedal robots and participated in robot fighting tournaments. Since working with robots is more difficult than with RC toys, I worked to expand my knowledge by attending workshops and learning more about them on my own.

What did you do for extracurricular lessons and club activities?

I was a member of the kendo club when I was in junior high school, and the fencing club when I was in high school. I also competed in the Inter-High School Championship for fencing. I have good memories of competing in the team matches against Yuki Ota's team, who won the silver medal at the 2008 Beijing Olympics.

In addition to fencing, I started learning the violin when I was a child. I kept playing for over 10 years, and joined an orchestra in university. Currently, my wife and I are blessed with two young boys, and we have been talking about how it would be nice to play an instrument with our children, and we've been trying to figure out what instrument to introduce them to. Both parenting and being a part of an orchestra serve as topics that intersect with my research. When you are directly involved in something, you really do become more aware of the kinds of issues and challenges it brings.

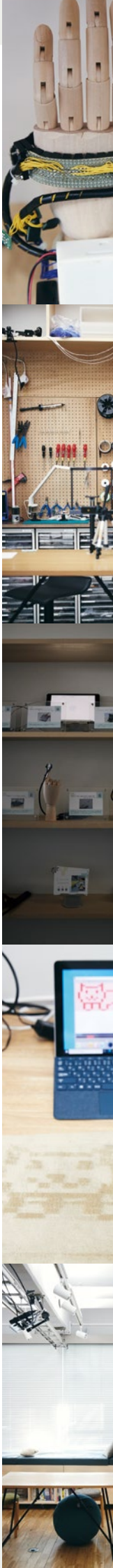
I also played a lot of games upon entering university. Video games are an embodiment of human interfaces. Through games, we can learn what entertains people, and the mechanics that facilitate such engagement. Many of the graduates from my lab have gone on to work for video game companies. Through research, we can discover new challenges to tackle while developing our abilities to solve problems. Consequently, this opens various career pathways, ranging from consumer electronics to the consulting industry, that leverage our acquired expertise.

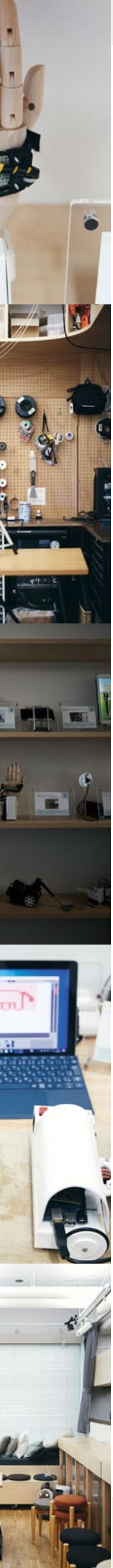
What was your student life like when you were an undergraduate?

After graduating high school, I went to the University of Electro-Communications (UEC). At UEC, there were contests held where participants competed against each other with their ideas, fostering a venture mindset. When I was in my second year as an undergraduate, I submitted a proposal for the idea of a bipedal robot which I had been building as a hobby, and won first place in that contest.

My idea was to have a person control a robot that picks up on certain stimuli, and to have that sensory information relayed back to the operator, aiming to recreate the immersive experience of the robot in the operator's perception.

At that time, I was interviewed by a website that focuses on robotics. It was then that I got an unexpected email from Professor Masahiko Inami, who was then a professor of UEC and is now a professor at the University of Tokyo. After reading my interview, he reached out to me and acknowledged, "The idea you wrote about is the very concept of telexistence. It's an idea that my own professor Susumu Tachi proposed for the first time about 20 years ago. If you're interested in this field, why don't you come join my lab?" Telexistence refers to technology that allows one to operate a physical entity in real-time, seamlessly replicating





Nothing can replace creating an environment that fosters communication.

Yuta Sugiura

In March 2013, Yuta Sugiura received his Ph.D. in Media Design from the Graduate School of Media Design, Keio University. The following year in April 2014, he was employed at Keio as a project assistant professor. In April 2015, Sugiura became a research fellow at the Digital Human Research Group, Human Informatics and Interaction Research Institute (HIIRI), National Institute of Advanced Industrial Science and Technology (AIST). He became assistant professor at the Department of Information and Computer Science, Faculty of Science and Technology, at Keio University in April 2016. In April 2018, he continued his employment at Keio as a senior assistant professor. As of April 2020, he is currently employed at Keio as an associate professor. He is engaged in research on human-computer interaction.

the experience of being in proximity. Thanks to Professor Inami's opportunity, I was able to join his lab from my second year as an undergraduate, and I thereby began my research on intuitive human interfaces for bipedal robot operation.

At that time, I only had a vague sense that I wanted to conduct research on robots. However, after listening to Professor Inami, I discovered that what I really wanted to study was the human interface.

After joining Professor Inami's lab, I understand that you skipped a year and entered the Graduate School of Media Design (KMD), correct?

KMD was founded in 2008 with the purpose of developing leaders and innovators who would be able to excel across various disciplines and make an impact on the global stage. When Professor Inami joined KMD as a founding member, I wanted to enroll as a member of their first cohort of students, so I withdrew from UEC in my third year, took the entrance exam for KMD, and joined the graduate school.

I pursued my master's and doctoral degrees at KMD. As a master's student, I made robots including one that could fold laundry in the way you instructed it to, and one that could cook your favorite recipe when you told them how. At the doctoral level, the main focus of my research changed to "soft" objects. For instance, I developed systems where you could use cushions as controllers. The products we have developed to date are on demonstration for visitors during lab tours so they can partake in research experience firsthand.

What is important to you when managing your laboratory or teaching students?

In April 2018 I established the lab that I now lead. During the process, I carefully considered the necessary features of the lab space and spent a significant amount of time deciding how to arrange the desks and experimentation space. Recognizing the impact of environment on people's performance, I also focused on arranging the space in such a way that would foster effective communication. I made it so that people could have discussions about research or light chit-chat in the free space, or if they wanted to concentrate on their studies or conduct research they could move to the desk space. We set aside clear distinctive spaces for different activities.

We also included finer adjustments. For example, we made it so that when using the coffee maker, you would have to pay to drink alone, but if two or more people were to drink together, the coffee would be free of charge. This approach encouraged students to invite someone else to join them for coffee, and there communication would occur. This means that I am the one picking up the bill to provide my students with free coffee, but I believe it is worth it.

What do you think is Keio University's strength?

The first strength is that the number of students is small relative to the number of faculty members. When advising them, this allows for an environment to see each student individually and to give them the best guidance possible.

Another advantage is that there are many international students. Since there are many classes conducted in English, it becomes more accessible for international students to join. For the Japanese students, it is also a good chance to broaden their own values by learning about cultural differences through their interactions with international students.

I believe that being able to spend your time as a student in this kind of environment will prove to be a great asset in the future.

◎ Some words from students . . . ◎

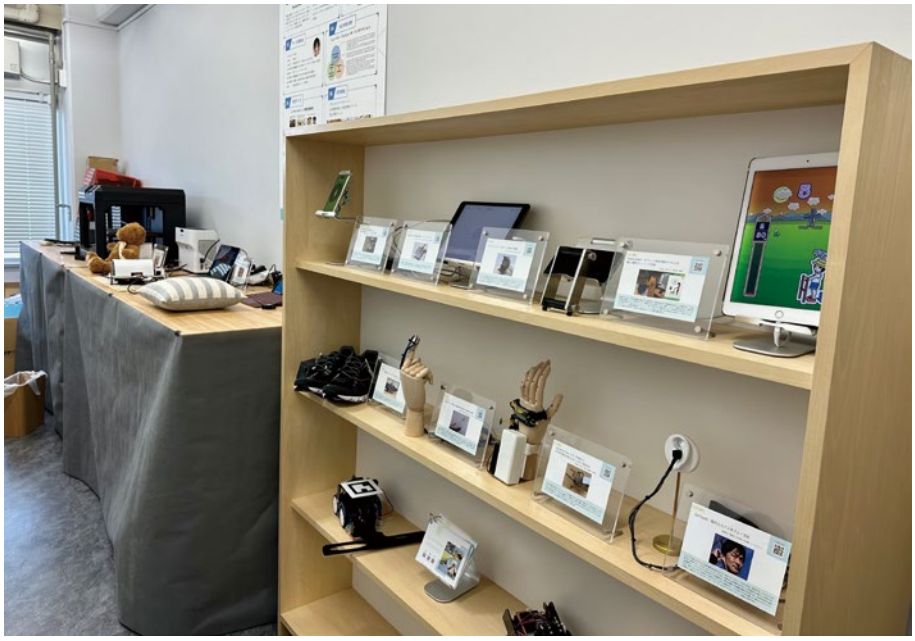
● I am conducting research on computer output. The fact that Professor Sugiura is a young researcher with a wealth of experience is also a strong plus. I thought that if I am going to create something new, I would want to study under a young researcher. I also like the environment where I can have discussions with Professor Sugiura as much as I'd like (2nd year master's student).

(Interview and text writer: Chisato Hata)

For the full text of this interview
https://www.st.keio.ac.jp/en/kyurizukai/

Research showcase

This is the demonstration space for the lab. Since we have worked on many interactive projects, we have showcases like this one to allow visitors to experience our devices firsthand.



Postcards

I and lab's students made these postcards together. Every single sheet summarizes an individual research project and can be taken back home by visitors. We frequently initiate new projects, and the stack of postcards keeps growing.

Hands-on research activities for students from Keio University's affiliated schools

Here, students from Keio University's affiliated schools could get the firsthand experiences of conducting research at our lab. We actively organize these activities with the intention of assisting students in making informed decisions about their career paths or choices of faculty to enroll in.

Yuta Sugiura's ON and OFF

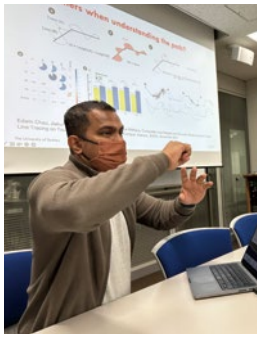
In this section, we showcase daily life at the lab not covered in the interview.

Taking breaks with board games

We often play board games to relax. As a result, our shelves are stocked with a variety of board games. I also think it's valuable because the insights gained through this kind of play can spark new ideas for research.

International research network

Our international collaborations are also very active. We have been working to foster global networks by having students from abroad come to our lab while also sending students overseas as well.



Field trip to Yumemigasaki Zoo

Not many students know this, but there is the Yumemigasaki Zoo, which is a 15-minute walk from the campus and offers free admission. It's the real deal, with penguins and other animals. This photo captures the field trip with our lab members.

Instagram

Our lab also maintains an active Instagram account where we regularly share updates. We post not only our research outcomes but also our daily activities, so make sure to follow us for the latest updates!

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My favorite books

Learn through Illustrations! How to Write Well for Students in Science and Engineering (text by Kentaro Fukuchi, illust. by Takasuke Sonoyama, Shoeisha)

As soon as you enter college, you are faced with the challenge of undertaking lengthy writing assignments for classes and experiments. The skills acquired here can be very helpful for your graduation thesis. This book will give you a good start on acquiring writing skills and will accompany you throughout your college journey. It is richly illustrated, easy to understand, and includes practice exercises, making it a valuable resource that can benefit high school students as well.

The New Media Reader (Noah Wardrip-Fruin et. al., The MIT Press)

Today's computers are so convenient to use because of the inventions created by our extraordinary predecessors. Their famous texts are compiled here in a single volume. This book offers an opportunity for readers to revisit the birth of media technology that we now take for granted. Although the text is in English, the writers use clear and sentences and can be easily understood by undergraduates to study English.

Research Method in Human-computer Interaction (Jonathan Lazar et. al., Morgan Kaufmann Publishers)

In the field of human interface, there are many research questions that cannot be answered by simply evaluating the performance of a system. This is because the human experience itself can be subject to evaluation, and there are many different types of evaluation methods. This book provides a comprehensive introduction to those types of evaluation methodologies. In our lab, we hold a workshop every year to read and discuss the contents.

Reading science fiction is another good way to generate research ideas. The bookshelves in the lab have sci-fi comics and paperbacks. Two of these books are presented here.

Inherit the Stars (James P. Hogan, trans. by Hiroaki Ike, Tokyo Sogensha)

On a lunar expedition, a human body in a space suit from 50,000 years ago was discovered. How is that possible?
This is science fiction that uses the scientific method to unravel mysteries. It'll make you realize that science is fun!

The Martian (Andy Weir, trans. by Kazuko Onoda, Hayakawa Publishing)

A scientist finds himself in an extreme environment struggling with his knowledge and ingenuity to survive. This is the type of science fiction that overwhelms you with the sheer joy of working with engineering.

The Mind That Fantasizes, the Hand That Thinks: How to Create Ideas That Surpass the Imagination (ed. Junichi Rekimoto, Shodensha).

This book is a must-read for students and prospective students of science and engineering, especially for those who lack confidence in generating and expressing their own ideas. Read this and bring your ideas to life. Shape the future with your own hands!

Theories of the Jizai Body: The Future of Mankind Interweaving the Supersensory, Supersomatory, Transformatory, Duplicatory, and Fusionary (Masahiko Inami et. al., NTS)

This book will make you question what constitutes your physical body. This is the latest case study from a cutting-edge researcher who is working on human augmentation.

Fencing and Technology

Yuta Sugiura

As mentioned in the interview, I was a member of the kendo club in junior high school and the fencing club in high school (see page 4). In high school, I competed in the Inter-High School Championships and played against Yuki Ota's team, who went on to win the silver medal at the Beijing Olympics. We ended up losing that match, though... I didn't think much about it at that time, but fencing is a unique sport that was ahead of its time in in embracing technological advancements.

This event has a long history and was one of the events conducted at the first Olympic Games. Fencing, as we all know, is a blade-based combat sport with multiple disciplines, and each employs different weapons and target areas. Fencing used to be the subject of various disputes related to scoring because the blades swing extremely rapidly, and the higher the level of competition, the more difficult it became for the judges to make objective and accurate judgments with the naked eyes.

To solve this problem, an electric scoring apparatus was introduced in the épée events of the 1936 Olympics to accurately determine whether the blade had touched a valid target area. This implementation not only promoted fairness but also led to an explosive increase in the number of competitors. Today, electric scoring is used for a variety of competitions. Technology has become an intermediary between competitors and judges to level the playing field and ultimately make competitions more exciting. Fencing was a pioneer in this area.

It isn't just the technology of fencing that has evolved. The rules of the sport itself have changed even in the span of time since I quit playing. Before then, many attacks were performed by swinging the blade and having it hit the opponent's back, taking advantage of the sword's suppleness. This technique is very different from swordplay as it was originally intended. Fencing calls for a point to be made when a certain amount of pressure is applied to the tip of the sword, but the criteria for judging the pressure was changed.

As a result, fencing took on a form closer to the original style as performed by knights in historical combat. The aesthetic beauty associated with combat has led to bold rule changes even in competitions with a long history.

This dual aspect of fencing—tradition and modernity—has renewed a sense of fascination of the sport within me, and I still enjoy watching the Olympics and other TV broadcasts when they are held.

理 工 学 Information

The 24th Annual Science and Technology Exhibition, KEIO TECHNO-MALL 2023

A Place for "Human Companionship" to Create New Collaborations - Chance and Challenge in an Era of Change

After being conducted online in the 2020 and 2021 academic years, the Keio Science and Technology Exhibition KEIO TECHNO-MALL returned last year and was held on-site at the Tokyo International Forum. This year, too, Keio University will present research at the Tokyo International Forum on Friday, December 15, 2023.

In addition to the Undergraduate Faculty and Graduate School of Science and Technology and the School of Medicine, SFC and the Office for Open Innovation's Startup Division are scheduled to participate in AY2023. As with the previous year, we will continue to provide you with information about AI, robot systems, medicine and healthcare, manufacturing, electronics, nanomaterials, the environment and energy, information technology and telecommunication, biotechnology, social infrastructure, foundational science, and Keio-launched ventures.

Around mid-October, an invitation for visitors will be posted on the website shown on the right.

Details: https://www.kll.keio.ac.jp/ktm/

Editor's postscript

For the 38th issue of the Kyurizukai, we featured Associate Professor Yuta Sugiura, who is conducting research on "soft interfaces." We hope you also enjoyed having a glimpse of his beautiful wood-adorned lab.

Sugiura emphasizes communication in his research and teaching, and it truly felt that he really likes people and is aiming to solve problems to make our lives better. We hope that through this publication, you can discover how the different topics studied and researched about at the Faculty of Science and Technology is applied in real life and society at large. (Midori Nakayama)

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