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Dong Soo Kwon

IEEE RAS Interviews

Q1: So let us begin with a little bit of personal history. So if you could tell us your full name and where you were born.

Dong Soo Kwon: Yeah, my name is Dong Soo Kwon. I was born in Seoul, Korea.

Q1: Can you tell us, if you'd like, if there are aspects of your family history that are relevant, you're welcome to share. But also please tell us about your education and your academic training.

Dong Soo Kwon: Okay, my mother was a housewife and my father was a business person. Yeah, he was doing some constructions management. And then my academic background is, I graduated Seoul National University, Mechanical Engineering, undergraduate. And then I did master degree at KAIST, Korea Advanced Institute of Science and Technology in Korea. And then I had a PhD study in Georgia Tech, Atlanta, US.

Q1: Do you happen to remember the first time that you saw a robot, whether that was in a book or a film or in person, do you have that memory?

Dong Soo Kwon: Oh, of course! Yeah. Our generation grew up with a movie of Atom. They know flying, humanoid robots, yeah, made by Japanese cartoons. We were dreaming some kinds of robot system is kind of what the human friendly and the human helpers like that. But when I was a student, undergraduate students, I had a chance to visit Korean car manufacturing companies. And then I saw some welding robots over there.

Q1: And so that was your first encounter as a student or as an academic with a robot. Do you remember when you first decided that robotics would be the field that you pursue?

Dong Soo Kwon: Actually, when I started PhD study, I was planning to study about flexible automation more than robotics. I was very much interested in how to make efficient manufacturing systems, including robots and then other machining centers. However, when I went to Georgia Tech, they had a very nice program for flexible automation system, but it was mainly for the master course. So since I was a PhD student, I had to find some real PhD thesis topics. And then my advisor, Professor Wayne Book, he recommended to consider those control over space shuttle RAM INAUDIBLE. That project is funded by NASA. So I took that project and then that was some kind of starting point of my robotics research.

Q1: Interesting. Do you see or, how do you see the line between say automation and robotics? Is that a meaningful difference for you?

Dong Soo Kwon: Of course, yeah. For the automation, yeah, robotics is a very important element. But automation doesn't mean robotics, yes. Automation is some kind of total systems efficiency.

Q1: So coming out of your first robotics project in your PhD and working with NASA, what were some of the research questions that came out of that project and then guided you through the first stage of your career?

Dong Soo Kwon: Yeah, spatial INADVERTIBLE is very long manipulator, is teleoperated and then is very flexible. So system flexibility actually is a functional INADVERTIBLE of velocity, even though it's very flexible, if it moves slowly and then it behaves like a rigid system. But even though it is very rigid, but if it moves very fast and then it behaves like flexible beams, right? So I saw a space shuttle RAM INADVERTIBLE moves very slowly. So I had got idea, even though we, robot is very flexible, has a flexible structure. I thought, I can control the end point of the robot system precisely as I wanted.

Q1: How have you, so that's where your research began. How have your research questions changed over time? And why?

Dong Soo Kwon: Actually, it didn't change. Yeah, actually, so my thesis was specialized, especially focused on some kinds of flexible structure controls, especially end point control. So we were allowing the structure can be bent. However, if we can control the end point precisely, then we can maximize some kinds of speed of the motion of the manipulator.

Q1: Interesting. Were there particular tools or techniques that got developed over your research career that made a big difference? So on a small level, we might think about, say Microsoft Connect, or on a conceptual level, something like large language models. Have there been some milestone technologies or techniques that have emerged in your research?

Dong Soo Kwon: In my research career, it's a long time story. So it's very difficult to explain in one sentence. And then actually, when I started professorship at KAIST, I had three research group. One is Haptics. And then another one is Human-Robot Interactions. And then third one is Medical-Robotics. These are all related with the tele-robotics. When human is involved in control loop, we usually say human in the loop. And then, when we control the robot system remotely, we need to sense some kinds of remote environment, especially when manipulator, a robot, so grasp something or touch something, the operator should feel it. Okay, so it's related with haptics. And then, if we extend that kind of human-robot physical interaction to some opt-to communication or some cognitive interaction, and then opt-to emotional interaction, that is the

area of human-robot interactions. So we researched in that part for a long time too. And then real practical application is medical robots. Medical robot is a kind of good example of tele-robotics system. Surgeon is controlling at the master console. And then the slave robot actually is doing the operation at the patient body. So I thought I can add some kind of haptics technology to medical robot and the human-robot interaction technology to the medical robots.

Q1: So it sounds like your work has crossed a number of problem domains. How about funding sources? Has there been a primary source of funding or has it been a mix of government and corporate funding?

Dong Soo Kwon: Actually, after I finished PhD study, I had a chance to work in Oak Ridge National Laboratory. And at that time, I worked in tele-robotics section. So my main job is developing nuclear waste clean-up robots. In early 90s, that was a big issue to clean up the nuclear waste storage tank. So that needs very long and slender robots that didn't exist. So we had to build from the scratch. So my study in PhD, it was controlling those very long, slender robots. So that's why I was picked up in that project. So I learned a lot, how to make robust systems that can be reliable or durable in the nuclear environment. So in that case, yeah, I was funded by DOE. And then when I returned to Korea and the KAIST, at the beginning, yeah, I had to get some small fund from the companies. And then I applied to the government and then started getting the involved in national projects. So I believe about mostly, maybe 90% of my project funding is supported by governments.

Q1: Can you tell us a little bit more about haptics in particular and how that has changed, either in approach or in the kind of techniques that have been used over the course of your career?

Dong Soo Kwon: Haptics? Why are you interested in haptics?

Q1: It's not a topic that we have talked about in our interviews.

Dong Soo Kwon: Okay, actually haptics technology consists of three components. One is haptic sensing. So sensor is very important yet to measure to the textures or vibration or movement. And then actually haptic display, we need some actuator to really, how can I say, convey some kind of haptic information to the humans. So we need some actuators. So that is another very difficult topics. And then third one is some kinds of controls. When we convey some kinds of remote haptic signals to the operators, and then, if operator gives some comment, and then it will be the human in the loop, right? So there could be some kinds of time delay. If remote site is far away, our communication time delay could happen, then system could be unstable. So how we can stabilize whole system, that is another very interesting issues. So I mainly worked on some control issues and then haptic display. So we were very much specialized in designing the haptic actuators.

Q1: Interesting, thank you. As you think about, not just your own research, but the field as a whole and how it has changed over the time that you've been involved, how do you see the field changing? What do you think have been the most significant changes in the field of robotics?

Dong Soo Kwon: Well, actually, at the beginning stage of robotics, we were concentrating about how to control the position. So fast movement and the exact position controls. Then we moved to some kinds of manipulations. When robots are trying to grasp something and then handling, that is really necessary functions to do real work, right? Just positioning is not work, so manipulating something. And then robot should move. So they should identify their, its positions, and then they could navigate, right? So navigation is some kind of next level of the robot's task. Then nowadays we are asking robots to communicate with humans with a natural language, right? So with the AI technology, it's working. We can talk with the robots so they can accept the natural language command. Then we are asking the robots to think like humans, cognitive functions. And then we may, sooner or later, we'll ask robots has some emotions. So they can behave like humans with emotions. That's what I foresee the robots some kinds of technology developments and trend.

Q1: Yes, thank you. That was going to be my next question. Can I ask you to elaborate specifically on generative AI, which has gotten a lot of excitement lately? You mentioned communication in robot interaction. Are there other ways in which, well, first of all, what is your assessment of the significance of generative AI within robotics? And is that the primary mechanism?

Dong Soo Kwon: Actually, I'm not the expert of generative AI, but I'm one of the users. So I'm utilizing generative AI for cognitions and then communications.

Q1: Are there any other, so I think you covered the question about the future of the field, maybe the next decade or two. Are there any other exciting developments or research questions that you see coming forward that you haven't yet talked about?

Dong Soo Kwon: Actually, that was some HIAA research topics. So I was pursuing that kind of the cognitive interactions and the emotional interactions. So that is my main research stream. However, that is a little bit long way to go. So I was looking for some more practical application and I was looking for some more practical application and I was looking for some more practical area. That was a medical robot.

Q1: Can you tell us more about medical robotics, both what you're doing and also this process of taking ideas that are coming out of your research and turning them into kind of real world

products and real humans. Can you tell us about that process? Has it posed particular challenges? Have there been surprises?

Dong Soo Kwon: Actually, I was involved in some tele-robotics research for spatial trap and the nuclear waste cleaner robots. And then when I returned to Korea, how I can utilize that kind of tele-robot technology. So I thought medical robot may really need that technology. At that time, Intuitive Surgical just started. Intuitive Surgical company has been established in 1995. Yeah, that was the same year I started medical research at KAIS, 1995.

Q1: And so your primary medical applications are in robotic surgery and telesurgery, I suppose.

Dong Soo Kwon: Yes. Yes.

Q1: As you think about your own career, and I think you've answered some of this, but are there, what do you feel like your most significant contributions to the field have been?

Dong Soo Kwon: Yeah, I have worked as a professor at the university. So how can I say, I made some kind of more than 100 students, PhD and master's. So we published some hundreds of papers, and then I made 250 patents INAUDIBLE. Then I thought, we are the engineers. So just writing our papers and the patents and make the students graduate with PhD degrees, that could be more. That should be more, yeah, we can do. So I was thinking for a long time, how we can make a real product out of our research. So six years ago, I told my students, can we go to some kind of a real commercialization level? Your research is very, very INAUDIBLE. So if you just stop writing papers and then graduate and go somewhere, big company or go to university and then doing some other research, that is, I think that was not much, how can I say, satisfy. So I asked my students, I will volunteer to be the front line leader. Is there anyone who wants to join? So eight graduate students joined to establish a subtle company. So all their PhD study are linked with some future product we were imagining. So they could finish all their PhD studies, and then write papers. And then out of the research results, we could make a real product. I think I can be proud of that.

Q1: Yes, yes, it sounds that way. Can I ask, so you're obviously very proud of your experience with students and developing students, but also it sounds like you're changing a little bit, your approach to that. As you think about students today joining the field, and think about either the skills that they would need to prepare or to achieve success, what would those be? Or do you have advice for students in academia?

Dong Soo Kwon: Yeah, I think that is very important question. Actually, what I, I thought about what I have taught my students and then it was logical thinking, okay? We don't know what's the

solution, okay? We don't know how to approach, but with the logical thinking, we find a way and then find the best solution among we can make it, right? It may not be the best solution or optimal solution, but we can get the best one in that situation. Is that enough? No!

Q1: No, that's great! I can imagine that is a different way of approaching problems.

Dong Soo Kwon: Yeah.

Q1: May I ask, how has that been for you? So how have you experienced it, yourself?

Dong Soo Kwon: Yeah, so in order to make a real product, we need a lot of other knowledge. So my proposal to students to make a set of companies, let's learn other knowledge together, okay? We have to understand financing, and then we have to know some kind of regulations, and then we have to understand the manufacturing, and then some kinds of quality controls, and the older was some management. Yeah, we were the engineers and we didn't have any experience. So we decide to study together all other areas. That is a start.

Q1: As you think about this kind of changing approach to education and all of its dimensions, as you say, political and ethical and regulatory and financial, I'm curious what you think, is the field, as a whole, prepared for that? If so, what, or if not, what kinds of changes to academic and professional organizations do you think would be helpful in your approach?

Dong Soo Kwon: There are many programs at each university to encourage students to start their own business, right? So if we feel some necessity, yeah, we can do some studies, self-studies, or we can go and then learn, get some lectures and then learn it. That is also possible. So without any getting the credit from the regular course, that kind of was self-learning by the necessity. Yeah, maybe really useful and necessary.

Q1: Yeah, in your work with surgical robotics, I imagine you're interacting with other kinds of experts, surgeons, other medical professionals.

Dong Soo Kwon: Yes.

Q1: I imagine that's a learned skill as well. Do you think there are ways in which the field could educate roboticists better to interact in these kind of multidisciplinary teams or environments?

Dong Soo Kwon: If there are some, okay, that kind of program, it could be education program. How can I say multi-area education program? That might be beneficial. But what I did is I attended the medical, some conferences and learned from them. And then I also spent a sabbatical leave at the medical school and the hospitals. And then I made many interactions with the medical doctors and our students. So we invite them regularly for some seminars and we often go there and then observe their operations. So we understood what is their situation and what is their need, and what is their problem and what's the difficulty. So we tried to give some kind of better solutions for them. They need some kind of, they can explain what is some kind of inconvenience for them. But they do not know what kind of motion can be made and then help them. Yeah, they cannot imagine. So we are imagining the machine and then provide them and then make them adjust that machine that is really helpful for medical doctors.

Q1: As we near the end of our time together, are there any of your accomplishments or topics in the... topics in general that we haven't talked about that you would really like to talk about while we're here?

Dong Soo Kwon: Hmm. What should I say? Would you ask me more specific?

Q1: Oh, so there's so much we could talk about in terms of the projects that you've accomplished. And there might be an aspect of that that I haven't brought out that you think is very important to your own contributions, or there may be some direction, say, for the future of the field or important issues that you think the field is facing that I also have not yet talked about. So if there are any burning issues on your mind, please let me know. It's also fine if you don't.

Dong Soo Kwon: Yeah, in university educations, we motivate students some kind of personal interest. So research is starting with our personal interests, right? But research is supported mainly by the government. That means taxpayers' payments. So we should think about from returning to the society. And then some some scientists may think it may be very valuable to find some kind of law or natural law and then, or knowledge we didn't know. Then that may be good enough. But I told my students, we are the engineers. So we should create something new things that exist, didn't exist before. So by making that kind of machine, we may be able to contribute to the society. Not maybe, we should contribute to the society.

That means my personal interests should include some kinds of commodity value that may create more some values, right? Then that commodity value should have some kinds of customer values. If we make some something, a robot or some anything machines, if it is not create any customer's value, it's really in vain. So our education system do not teach rest of them. So we are just pushing students to motivate their interests and do research. But I hope we can make some kinds of education system to broaden students' eye, to look at from the beginning research interest and the final products, and then it can contribute to society.

Q1: What a perfect way to end. That's exactly what I was hoping for, a very personal call for the field. That was wonderful. Darryl, did you get what you needed? Thank you so much. Kind of what happens next with you?