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Yukie Nagai

IEEE RAS Interviews

Q1: Excellent. So my first set of questions are just about you and your background. If you could tell us your full name, where you were born, when you were born, and anything that you would like us to know about your family, if that's significant to your research or your career, and then where you trained in a school.

Yukie Nagai: Okay. So my name is Yuki Nagai. I'm currently working at the University of Tokyo. And I was born in Gumma Prefecture, which is at INAUDIBLE nose of Tokyo. And then first studied robotics in Aoyama Gakuin University, which is a private university in Tokyo. And then after finishing my master course or degrees in Aoyama Gakuin University, I moved to the Osaka University, where my PhD supervisor was advocating their new research area called cognitive development robotics, which is currently I'm also working on for more than 10 years now.

Q1: Excellent. Thank you. We're always curious about when people first discovered robotics. Sometimes this is as a child or as a young person, maybe through a book or a show. Do you remember anything about your first encounters with robotics?

Yukie Nagai: Well, the very first experience to know about robotics is only in the university days. I entered the universities with the first motivation to study, like a design of the car. When I was a child, robot was not so famous yet, or common yet. And then I was very much interested in engineering technologies, but focus is more on the car design. But then, after I entered the university, I met a very nice professor who is a Japanese professor, but who educated and also there are worked in US for many, many years. So he is very international professors. And then his lecture was very, very engaging. And then I found that the robotics is very interesting, the research area. That's why I started studying robotics only in the post grad of the university.

Q1: Do you remember your very first project in robotics?

Yukie Nagai: Yes, my very first project. It's not so focusing on the robot that embodied robot, but more the design of the artificial intelligence. And then we started designing the intelligent systems, which can generate the planning of their manufacture design or manufacture systems. And then I realized that the human intelligence is very, very smart. And the machine intelligence can never achieve human level intelligence. That's why I also started studying the human intelligence, as well as artificial intelligence. And of course, I found that the robots that embodied systems is very important for our intelligence. Intelligence is not only about the brain, but also, through the sensory motor experiences with the environment, the robot can learn a lot of things. So that's why I integrated the idea of AI study, human intelligence, and also the robotics.

Q1: Yes, thank you. That was anticipating my next question, which was about this relationship between embodiment and AI, and how you think about that, and getting the sense that you think about those together.

Yukie Nagai: Yes, when I first studied the artificial intelligence, I was also thinking that their intelligence is about their brain mechanism, neural mechanism. But then their brain, of course, is important, but then it does not have a real time, like in a sensory motor experiences. Our human intelligence is made through their embodied, their interaction with the environment. By exploring the world and also the acting on the environment, we can learn something new. And then also these new experiences allows us to integrate and also enrich our internal model. That's why I tried to integrate the idea of embodiment into the design of their artificial intelligence.

Q1: Given that perspective you have, what kinds of specific research questions have come out of this interest in all those INAUDIBLE?

Yukie Nagai: My current research focuses on the early developmental stages of the human intelligence. After their human birth, they start exploring the world and also their own body, which is very different from the robot, their intelligence. The human babies do not know yet how their body looks, and also how they can control their body. So they really start from scratch without any knowledge about the environment or even their own body. But then, through their explorations and also through their social interaction with their caregivers, they can learn so many things. And then that's why I'm very much fascinated by the child development rather than adult learning.

Q1: As you've been working to develop the cognitive aspects of this field, have there been particular challenges that have faced you? I'm thinking anything from the technological to funding, institutional or disciplinary challenges. What have been significant challenges for you?

Yukie Nagai: The significant challenge is that, even in the human sciences or neurosciences, their child development is not well understood yet. Maybe their adult brain or adult their embodied system is well investigated already. So there are a lot of knowledge in the neurosciences, cognitive sciences, but there still are a lot of open questions in child developmental studies. For example, children cannot tell us what they know, what they can communicate. So we have to also, need to carefully investigate the child intelligence itself. And then not only designing the artificial system, but also by utilizing the AI or robotics technologies for understanding the child development. That is the most significant challenges for our research area.

Q1: Who funds most of your research and have there been challenges associated with finding funding?

Yukie Nagai: Funding means research funding?

Q1: Do receive funding through collaborations or mostly academia?

Yukie Nagai: I have mainly received funding from the Japanese funding agencies. I think that, because also my research area is more focusing on the basic sciences rather than applications. So it's not so easy to have the collaboration with the companies. They are more interested in application sites. Then, I think the Japanese funding agencies are still very open to, not only to the applications field, but also the basic sciences, how the human intelligence arises and also how we can utilize the technologies to better understand or deeply understand the human intelligence. I have been applying for the Japanese funding agencies to get their research.

Q1: Are there particular tools or technologies? I'm thinking about things like Connect or large language models or instruments that have been really foundational to your research?

Yukie Nagai: Of course, there are recent advances in the neural network model, like a large language model is a great idea, or a great approach for us to utilize this for investigating the human intelligence. Actually, there are a lot of new insights. Also, their ideas are already integrated from the neurosciences to their machine learning or their large language models. So we utilize such a neural network model to simulate the human brain mechanism and also to simulate the human cognitive behaviors. One more very important platform for us is the humanoid robot, which is called iCub. iCub has very childlike appearances. It also allows us to study, not only their embodied sensory-remote interaction, but also the embodied social interaction. We investigate how human teachers want to teach something new tasks for children. Then also how the children and also the childlike robot can encourage the human teachers to teach something more easily understandable for the infant learners.

Q1: Thank you. What do you see as your most significant contributions to the field at the moment?

Yukie Nagai: I think that our research in cognitive development and robotics has a great impact, not only in robotics field, but also the cognitive sciences and the neurosciences. We have very long-time collaborations with developmental psychologists and also the neuroscientists, and then we can provide a new insight or a new viewpoint about the human intelligence, how intelligence arises and also how it can be utilized to assess the human cognitive development. I hope that our engineering robotics approach can have their impact on the human sciences.

Q1: Has there been anything that, as you think about how your research moves out into the world, whether it's into the cognitive sciences, or medicine, or industry, what do you think has been most interesting to you? Have there been any surprises as your research travels?

Yukie Nagai: You mean in terms of the research, the achievement or directions?

Q1: INAUDIBLE might be using your research for more applied purposes?

Yukie Nagai: Applied purposes.

Q1: Yeah.

Yukie Nagai: Yeah, I also have the collaboration with researchers working on the developmental disorders because the understanding of the human intelligence can also help us to assist the person who has developmental disorders or difficulties in cognitive functions. Then we utilize robots to first understand and assimilate cognitive individualities, or cognitive neurodiversities in autism spectrum disorders. Then, by utilizing our technology, we also design assistive systems for people with developmental disorders. I think this direction is a good application which can contribute to the society and also it gives a lot of new ideas or new hypotheses in our computational study as well.

Q1: That is exciting. I was going to ask you about what you saw the future of generative AI in your field. It sounds like you've answered that to a certain degree. Are there other exciting questions or technologies that have come about recently that you see as part of your research agenda for the next decade or two?

Yukie Nagai: Yeah, of course the generative model in a neural network community has a great impact also for us to understand the human intelligence, because the human brain also works as a generative machine. Our brain does not simply receive the incoming sensory signal but it also generates the new ideas and also the new creative thought, which can also change our world. How such a generative model can be also compared with the human intelligence or activities is a very interesting research direction we can address.

Q1: Are there research questions or directions that you have not yet been able to pursue because of other limitations or other constraints that you regret not pursuing, or that you would like to be able to pursue in the future?

Yukie Nagai: A difficult question. I think that I could have addressed there what I want to study by myself. Maybe one of the open challenges for us is to have also developing the embodied system. For example, we can design a neural network model which can learn and also develop its memory capacity, and also the perceptual systems on a software level. But then the developing embodied system is still an open challenge. We have the fixed size of robot and also their sensory or actuator systems is kind of fixed. But then the human chart of course grow year by year and also improve their sensory motor capabilities. Such a development in the embodiment is also very important for their intelligence development and improvement of the intelligence. So these two must be tightly coupled to deeply understand how the human intelligence arises. Still we have only their developing brain, but not the developing body yet. So I hope although I'm not the expert in the embodied system, I'm rather the user of the embodied system. But it would be great if we can have like a developing body which can be also integrated with a developing brain.

Q1: Yes, that's fascinating. As you think about the current state of the field, do you have recommendations or strategies for kind of students entering the field, how they can prepare themselves to succeed in this changing environment?

Yukie Nagai: I think that the robotics, the research area is very very interdisciplinary research area. I was listening to the other speakers talk as well and then I found that everyone somehow get the inspiration from their human behaviors, human intelligences. So the robotics is not just simple engineering or the computer science, the research area. But then it needs to integrate the neurosciences, cognitive sciences, even the developmental sciences. So for students, I really want them to have their open-minded and open perspectives to try to learn. There are many different ideas or many different knowledges from their different research areas.

Q1: Thank you. When you think, not just about your own experience, but the field as a whole, what do you think have been the major changes over the last decade or so within the field?

Yukie Nagai: Yeah, of course the advancement in the neural network architecture is one of the biggest development in our research field. I think that, in the early stage of my research career, the neural network was already used, but then it was still very limited to do only the visual recognitions or auditory processing. And then, if we limit the target area or the task, it could work to some extent but it cannot go beyond the human intelligence. But nowadays, there are many kinds of network models that can easily go beyond the human intelligence. I also often use, for example, the ChatGPT to check my English, for example, and also to check my papers. And then it is helpful for us to know what is missing and what can be improved. So I think that in this way we can better interlace such ideas and also that is a good way to go beyond. I'm sorry, maybe I forgot the question point.

Q1: In fact, you answered in a number of different ways. My next question is about what you think are likely or need to be key developments for the next 10 or 20 years in the field. You've talked a little bit about generative AI in neural models and developmental bodies. Are there other things that you think are really important for the field as a whole in the next decades?

Yukie Nagai: Yeah, I think that, besides the embodiment and also the generative ideas, I think the one important thing that I really want to emphasize is the diversity in the intelligences. Because I have been studying the neurodiversity in the human intelligences. And then the human intelligences does not always show the optimal solutions, but the different persons have different thoughts, and different ideas, and different policies to achieve the same goal. And then I realized that such a diverse thought or diverse ideas is very important for sustaining our society and also to make it more creative ideas. But yeah, compared to such a human intelligence, the current AI, our robotics still try to achieve the optimal, maximize their solutions or optimize the solutions. But we should look more at the diverse ideas or diverse thought. There is not like a good idea or bad idea, but rather try to integrate a different thought and a different perspectives. That is very important, I think, for also for the future of AI.

Q1: Since you mentioned diversity, I'm going to ask you a question that you feel free to not answer or answer in any way. But, as a woman, in a field that is historically male-dominated, have there been particular challenges for you? And then are there maybe recommendations for women coming into the field that you would have from your own experience?

Yukie Nagai: Luckily, I did not have such a big challenges as a female, the research or a female student in this robotics area. Maybe my professors are very open-minded, and also they encourage the female students to be internationalized and also get the network for the interdisciplinary research areas. I heard from some female students or female young people that they sometimes have such difficulties. If their professors are not so open-minded, maybe they have some challenges in their research career. But then I'm very, very happy that all the professors and supervisors are very, very open and always very, very encouraging. So that's why I could continue working in this research area.

Q1: Do you collaborate much with industry? And, if so, what does that look like for you?

Yukie Nagai: Well, so as I said, my research is more focusing on the basic sciences. I don't have so much collaboration with the industry. Only one is not a technology industry, but there is a company in Japan which provides assistance for their children, especially with the children with the development of disorders or any kind of disorders. And they try to integrate our ideas and also the assistive technologies in their schools and also like an educational system. That is the one, only one collaboration I have with the industry.

Q1: So you talked a number of times about your work with children, child development, neurotypical children. Can you say a little bit about what that looks like? Do you work with human subjects directly and what kinds of challenges or opportunities does working with children INAUDIBLE?

Yukie Nagai: Yeah, we are conducting the studies with the human children, not only with robot, but also that we directly assess their cognitive behaviors, cognitive functions. And then we are often amazed by their very creative ideas and very diverse cognitive behaviors. For example, in one of our studies, we asked children to draw some pictures on the tablet. There is no like a correct answer or something. It's a very free drawing. And they showed a very diverse and very, very creative drawing patterns, which really nicely shows, of course, the development of improvement, but also the individual differences in their like a world model, how they see the world, how they perceive the world. So these, their perceptions can help the individual differences. And then drawing can be a very good window to look into the human's cognition, children's cognitions. Yeah, we are so much amazed by their very creative ideas and drawing patterns.

Q1: As we approach the end of our time together, is there anything that you would like to share that we haven't talked about yet?

Yukie Nagai: Oh, well, INAUDIBLE Yeah, I think that, so, we are now having like a 40s anniversary of the robotics conference here. And then my career is still have like a 20 or 25 years now. And then I could still learn many new things from the senior professors and also from the younger professors. And then this kind of conferences is a very nice places for communicating and networking. And then I'm also very happy to know the new people and also share our knowledges. And this research, has a very important, having this kind of human network as well, not only like a scientific knowledge or other technologies, but also the how we can expand our human networks, because there are one person's intelligence or one person's ideas still limited. But having the human network, we can also diverse our thought and also extend our ideas. So I think that this kind of a human network is a great places to have. So for the younger students, younger peoples, I want to encourage them to have their very nice network, international, interdisciplinary network.

Q1: What a perfect way to round out this interview at this particular conference. Thank you very much.