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Wenzhen Yuan

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Q1: Tell us about yourself.

Wenzhen Yuan: My name is Wenzhen Yuan. I was born in Qingdao, China. And about my family, my parents work in university. My dad is a professor, and my mom is an administrative person in the university. And I was the only child of the family and had a pretty happy childhood. Based on since I was the only one and they gave me all the love and attention.

Q1: Tell us about your college experience and mentors you had.

Wenzhen Yuan: I took all my elementary school, middle school, high school in Qingdao. It's like in my hometown. And during college, I went to Beijing and attend the Tsinghua University in China. And after that, I came to US, I went to MIT for both my master and PhDs degrees.

Q1: Tell us about your work experience.

Wenzhen Yuan: After I got my PhD degrees where I spent like so many years in schools. So I went to Stanford for one year for postdoc experience. And then I went to Carnegie Mellon University - work as a faculty member for four years. And then last year I came here at University of Illinois and continue as my career as a faculty member.

Q1: How did you get interested in robotics?

Wenzhen Yuan: Wow, that is a very, very long time ago. So I even can hardly remember that. I got really interested in robotics. since I was a little kid. So I think it's super cool idea is to build an intelligent agent that can work by itself and can have its own ways to interact with people and interact with the environment. And I feel like there's so many things we need to handle in building the systems. Like we need to build a very nice hardware, the body of the robots. And we also want the robots to be smart. We need to build a smart mind of the robots. And that is really fascinating to me. And that inspired me to start thinking about robotics and wanted to work in robotics since I am a very early age.

Q1: What was the first robotics project you worked on?

Wenzhen Yuan: That's interesting. So actually I would consider my first robotics project was the one in the middle school. So nothing special is more like a case robotics hobby programs.

So during the programs we are supposed to work on a small mobile robot or only those things we can control or to use them, make these small vehicles in a small room. And our goal is to make the programs, our goal is to program the robots to make it move around the small rooms and search for some specific targets. So it was fun and not fun enough. It is fun because it's really exciting to see the first time we can progress something and very control a robot moving. But it's not fun enough that like, I feel like at that time it's so simple. Like what we can do is so limited with this very simple machine. So that kind of is a, turns out to be a great inspiration for me that want me to go to a better platform and get the opportunity to work with like more complicated robots.

Q1: Tell us about the following projects that you worked on.

Wenzhen Yuan: So during college, so my major was mechanical engineering and to continue exploring my interest in robotics, I joined a lab that works on robot hand. So the main focus of that big project is that I together with several other fellow students want to build a system of robot hand that can do different things to different grasping. And we built the hardware as well as the software. So my major role was like developing a software so that like the system can recognize human's gesture and use that as a reference to control the robot hand. So that is the one I worked for several years and was pretty fascinating. And also spent some time on some small projects is more on buildings and robots that is really helpful for industry such as like soldering big parts or adding some materials to a big manufacturing - I don't know what it is. It was so many years ago - like the being of things, adding materials to the manufacturing side, you know, control the way.

Q1: What were the main research questions you were interested in?

Wenzhen Yuan: So for many years, since many years ago, I have a strong interest work on robotics and I want to build a more intelligent robots. And they always my strong beliefs that a smart robots or intelligent robots means that it has a very nice physical parts, which means the body of the robots. And also like very smart mind, which means like a well-designed algorithms to control the robots and understand how the robot is interacting with the environment. And it's pretty surprisingly over the years, I would say like over more than a decade of times, although my understanding about robots has changed as time goes, as I know more about the field, but the basic philosophy didn't change. Still think like it's so fascinating and an important thing to find a good way to combine the physical part and the algorithm parts in order to make a good robot.

Q1: Tell us about your connection with sensory and tactile robotics.

Wenzhen Yuan: So the hand project is the one kind of, I would consider seriously introduced me to the field of robotics. And it's definitely a fascinating and very important part of robotics

because hands are so important for both human and robots. So as a, we can think about this from the perspective of humans. As humans, we can do so many things with our hand in both like manipulating the objects, such as like interacting the things in the environment and changing their state and also perceiving the environments. Like we touch the you, we touch everything in the environment in different ways and understand what's the state of those objects, what's the physical property of that. So after I worked on a robot hand for a while, I realized that on the perception side tactile sensing is really a fascinating field. So it's not the well-developed is very difficult, but it is very important. In order to make the robots really dexterous and intelligent on the hand part in order to impact this environment, we need the robots to have very nice tactile sensing on the hand.

Q1: What are the technical challenges you've faced in your research?

Wenzhen Yuan: So one of the biggest technical challenge is the request of interdisciplinary knowledge and expertise in order to conduct research in tactile sensing and even many other fields in robotics. So as I mentioned earlier, I believe in order to be an expert in tactile sensing, we need some efforts on hardware design and some efforts in software or algorithm design. But for some historic reasons, I think our students are trained in and shaped into different fields and different directions. Like some of them get trained in mechanical engineering about designing and building things. Some of them are trained and shaped in electrical engineering about circuit design and making surface. And some of them are trained and shaped in computer science so that they're good at programming and developing algorithms. But in order to make a good robot, we need to be good at all parts of it. And that has been a challenge for researchers and the team.

So when I build my team, I try to be very specific about having different team members coming from all those backgrounds so that although each students will start with an interdisciplinary background, but our team is pretty interdisciplinary. And as time goes, I hope to foster this environment that they can talk to each other, learn from each other so that they can grow a great width of the knowledge scopes into robotics. So that is one of the biggest technical challenge. Another thing is that I also noticed that there's the shifting the culture about doing research. So nowadays, like everything is getting more and more fast paced. I know that in some fields on some topics, students may publish paper very quickly. But also in some fields, I think like tactile sensing, if we really want to take deep and do some really pioneering study, takes a lot of time of thinking and reading and learning and try different things. And fail and try again, fail again. And finally you may succeed. And that may take four years. So I think in the classical times, I don't know, probably decades ago, like what people expect for PhD career is that like the students may dig into a single question for several years, think very deep, take very deep hand. They don't really publish a lot of papers, but they came up with a very, very nice thesis that is really completely well covered in part topics and really post some like fundamental improvements and new insight into the field. But nowadays, like the entire culture is not like that anymore. Like there's a peer pressure for students to publish very quickly.

So I also feel like it's pretty hard for students to like sit down and think into some questions very deeply for several months or even one or two years. So I think this is also making

it a little bit hard probably on the institutional side. So another big challenge on the institutional side is the difficulty to maintain a big group. So for people who need to work with a INAUDIBLE, especially like if there's a need to combine hardware buildings and software buildings, but that old INAUDIBLE limit means that there need to be significant efforts on building the system, maintaining the system and try out different algorithms on the system. So that means like through this process, like lots of time the system may fail and it will take significant labor powers and the time to fix all the problem. So that also means that like typically there should be a large enough team for within a single group so that multiple people can work together for single projects. But it also means like that there's a big financial pressures in maintaining a big group like that. And nowadays it's harder and harder to find enough financial support in academia to maintain a big group like that.

Q1: How are you addressing the changing landscape of robotics?

Wenzhen Yuan: I don't have good method for this. So I'm I think I'm just a junior faculty haven't studied academia for many years. So I need to fit to it and but at the same time trying to do a little bit of things on my side. So I have a little small tricks to try to pursue like most ideologies and also consider the practical ones, but like probably it's not a good thing to record in a documentary.

Q1: What is your experience with funding for robotics projects?

Wenzhen Yuan: So I have some funding from NSF. They are very nice in funding some basic research but like they also have limited resource that's unfortunate and also have been pretty fortunate to get some support from industry. Like several years ago, there's a increasing in interest in industry in the big companies for developing their own robotics team and explore possibilities in robotic research. So it's pretty unfortunate like some of them got interested in tactile sensing and support some own part of my research.

Q1: Has funding had any influence on your work over the years?

Wenzhen Yuan: Yes, definitely. So I think like the funding is like we need to do the things that the sponsors would like less to do. So for example, with the industry, our founders they want to develop their robotics research but they also want to, so their focus is building something that is more practical and closer to the final application side. Like currently there's less interest from industry to develop some fundamental technologies or fundamental knowledge in robotics. So in order to get support from them, so I need to work on the things they are more interested in that is more on the application side. So NSF is better than that, but also there's a little bit challenge from NSF that like is shaped by humans and people may have different views about what fundamental things are more important in robotics. So in other words, like it's more easier to get

support from NSF like if you work on the thing that is already pretty widely agreed by the good community that they're important. But also like, it also means like if you have some adventurous thoughts about like some like a very, very new thoughts, you might, it might be harder to get a wider agreement within the community. So it's a little bit hard to get support from NSF in this case.

Q1: Do you partner with companies?

Wenzhen Yuan: So like I said, like I got some opportunities that some companies are interested in doing robotics. So I'm trying to work together with them to help them to explore more about opportunities in robotics tactile sensing. And I've been also involved in some like more closer to application side. Like recently I've been working with several companies on manufacturing. So they have some real manufacturing problem which is service inspection with tactile sensing. And my student and I worked together try to develop a technical solution for them. And we also test our system in their real, not the real factories by at least in their lab. And I think that is a very good opportunity for us to understand more what does the industry really need for the use of robots or robot technologies and can shape our research more towards this kind of real applications.

Q1: Are there any other topics you have not yet pursued?

Wenzhen Yuan: So there are several topics I'm super excited about. So I work on tactile sensing. I spent many years building tactile sensors and show the community what can tactile sensors help the robots to do. For example, like if you've a robot grab something, you can you can based on tactile knowledge to understand. like it's objects falling away from your gripper or not. Or if we ask the robot to touch some surface, can you understand like if it's a soft surface or rigid surface? And even if you are shaking the bottles, you can there's based on the vibration patterns, you can understand what's in the bottles. You can understand is this like a large part, large particles or small particles? Or if it's liquid, it's viscous liquid or less viscous liquid. So they're pretty interesting and demonstrate lots of things like robots cannot do before. But I also feel like they are more like a case to case by case. It's just like we look into our sensors, look into our robots and think, oh, what can the robots do? Probably they can do this. Let's see how can a robot do this? How can a robot do that? But instead also so deeply in my heart, I always want to have a chance to look into this problem systematically. I understand more about the most foundation basics between the interactions, between between the sensors and the external environment and see that like how this can give us like fundamental understanding. What are we really learn from tactile sensing? How can that guide the robots to better perceptions or manipulation tasks?

Q1: What is your most important contribution to robotics?

Wenzhen Yuan: I've been working in tactile sensing for robots for many years and having a pioneer in the field. So especially since my PhD time together with my lab mates, they firstly introduced the variant based tactile sensors, specifically Gel-site to the field. So Gel-site is a very specific sensor. They can provide a very high resolution information about the contact

surface. So with the Gel-site, you can see lots of fine details, like those fine textures on INAUDIBLE on different garments and also like the shape of the contact surface, like are you touching a sharp edge of the table or a flat wall? Or are you touching a handle of the door or whatever? So this is pretty revolutionary in the field of tactile sensing, because before that, the tactile sensors people use are like low resolution, array based tactile sensors that has a spatial resolution of like a few millimeters. So which means like if you install that kind of sensor on a robot grippers, you can see there's something touching the robot hands, you're touching something, you can estimate the force and you can see very roughly with the shape, like is it like a flat surface or something like a little bit curved surface or a dull surface, but like there's no way for robots to see very fine details about what is really happening on the surface. And with our new sensors, the robots can feel a lot of things, a lot of information on the contact surface. So after that, I also spent many years to look into that.

Once we have this nice community, nice informations, what kind of information can how can it help robots to extend its capability of perceiving the INAUDIBLE or touch? Like, of course, we know that I can see the shape, we can see the geometry or textures very well, but can we see something beyond that? So then I work on examples about like detecting slip or the micro slip or even the incipient slip during the grass fields cases, and also feel touch different objects and try to understand some physical properties, such as the hardness of the surface or through some indirect interactions. Can we understand like the viscosity of the liquids, the volume liquids or for solid particles? Can we understand like are they big particles? Are they small particles or are they sticky particles or are they pretty dried hard particles? Also, we have explored different cases about using this more sensitive and rich information from tactile sensors to help robots to do better manipulations such as cable routings or cooking, things like that.

Q2: Cooking?

Wenzhen Yuan: Yeah, we recently have a paper in submission about making a robot to do pancakes. So it sounds fun, but there's lots of there's lots of science and technologies behind that.

Q1: How have robotics changed, and what upcoming developments do you expect?

Wenzhen Yuan: What is definitely get a very dramatic improvement like many perspectives over the past years. So there are several things that is really helpful in this entire progress that definitely I would prefer they put on the advance of the computations or the big popularities of deep learning technologies. So I think to some extent it's fundamentally changed the state of our of local perception, especially to range sensing such as visions or letter and readers. So they introduce lots of new possibility to robotics. And other than that, there's other like improvements from other perspectives, such as the emerging of a better hardware for robots. And more

companies has been drawing this drawing this field and producing better and easier to use hardware, which is highly beneficial for the entire communities.

And also, like the introduction of new material technologies and fabrication technologies are enabling better robot hardware. So so far more on top of my mind, I think those are the most important or most influential drivers first in the entire field. So regarding to where I see in the future. I think like those new technologies in computation, like deep learning and in the help in perceptions and even the robot planning and the robot, what intelligence will drive the field to go forward for at least a few years. And in the long term, I believe like the advance of manufacturing new materials and new hot mirrors will also be a strong drive force of the field.

Q1: Has Generative AI made significant impacts on robotics?

Wenzhen Yuan: It is happening. So I think it has greatly helped robots to do one thing is have a deeper understanding about the environment, about what happening and also combined with like large data, large data set. The robot can understand can do a much better job in reasoning about the environment and understanding like what are some high level plannings about interacting with the things in the environment.

Q1: Have the results of your research been applied in real-world situations?

Wenzhen Yuan: That's a good question. So my research haven't been really applied in any commercial life. The same. So, though, I heard lots of interest about using our research results and I do believe like in the long term, it would really help for making the real robots. But in the short term, we do have run into some engineering difficulty and make it not easy to really apply the research for the real robots.

Q1: Is the “Gel-site” technology you mentioned provided by a private company?

Wenzhen Yuan: Firstly, it was developed at MIT and then some researchers from MIT left the university and started to start up and work on commercialized technology.

Q1: Has any of your work in that area been commercialized similarly?

Wenzhen Yuan: So I've been talking to them and saw how they commercialized the technology. So for many in the first many years, they focus on the industrial use of the sensors, not for robots, but like making big sensors for like the fine detailed service inspections or other kind of inspection tasks. But in recent years, so there is a big increase in the field of robotics and the increasing interest in tactile sensing and the company began to work on commercializing the sensors for robots. And the business just robotics just started for a few years. But I see I expect there will be like a pretty bright commercial future for that technology.

Q1: Do you collaborate or contribute to industry in any way?

Wenzhen Yuan: So I've been talking to them pretty frequently and I think my contribution so far is mostly give them suggestions about like when developing the sensors, what would the users be more interested in and what kind of things they need to improve for their product.

Q1: What advice do you have for students interested in robotics?

Wenzhen Yuan: I think this is a question that might be very different for many people. So from my personal perspective, I still highly value the capability of combining knowledge from different fields in robotics. So that means like I think in order to be a good roboticist in the future, students need to have knowledge in all the other fields of it, such as both hardware design, the modeling and understanding the control, the dynamics and also understanding the high level algorithm. So, of course, it's not possible or it's very difficult for someone to be an expert in each field. But I think it's very important to have some basic enough understanding and experience with all those fields.

Q1: What is your view on the social and ethical problems of using robotics?

Wenzhen Yuan: That's a very good question. I haven't thought of very deeply into this. I think at some point, we definitely need to think about like from the social perspective or ethic perspective, how can we make the robots to be beneficial to the broader community and to the public? So, for example, like recently we have been talking to NSF about like the using of robotic technologies for manufacturing. And it's very interesting for me to learn that from the NSF perspective, I think like a very important part is to use this opportunity to foster the workforce for manufacturing. So in other words, I think like different from like some general public we will see robotics that they think robotics are taking over their job opportunities. I think in the long term, we should look for a way for robots to be co-workers and humans and make robots as agents that help humans. So that means there are some new questions about like, what are the good ways for making the robots work together with humans and interface with humans, especially for humans who are not experts in robots? So I believe it is definitely like a good question for all the junior roboticists and for the entire field to think now and in the future.