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# Kazuhiro Kosuge

An interview conducted by

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with
Peter Asaro

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**Interviewer:** So if you could start by telling us your name and where and when you were born?

**Kazuhiro Kosuge:** Uh-hum. I am Kazuhiro Kosuge. I was born in Japan <laughs> in 1955 and yeah, actually I was born in Tsu City which is located in Mie prefecture. This is adjacent to Aichi prefecture. Aichi prefecture, the main city is Nagoya City so you may know where it is. That's okay?

**Interviewer:** Where did you start at school?

**Kazuhiro Kosuge:** Actually I was graduated from Tokyo Institute of Technology and my career is a little bit different from other professors in Japan. After finishing master course there I entered the Nippon Denso, one of the Toyota large companies and now it's called DENSO. And Denso means electrical equipment for automobiles. So they are now I think one of the largest companies in the world concerned with the electrical equipment for automobiles. And I worked there for two years and three months and then I graduated from the company. I went back to the again the original previous laboratory at Tokyo Tech and Department of Control Engineering and after that I joined a laboratory as a Research Associate and when I became a Research Associate Japanese. We have a little bit different Japanese system, which means that I could become a Research Associate without having PhD degree. And then I was working as a Research Associate and doing some research. I got the PhD there. And after that it took about eight years for me because I was working during the daytime and so my time for research was a little bit limited, but I learned a lot. And then I first I visited the United States for one year. I was with Harry Asada and he hosted me at the MIT Mechanical Engineering Department and I learned a lot from him. And then I joined Nagoya University Toshio Fukuda lab as an Associate Professor and stayed there four years and a half, and then I moved to Tohoku University and joined one of the departments relating to Mechanical Engineering and became a professor. So I became a professor at the age of 39 years old and the main reason why I moved is that I like to have do something by myself and that is a kind of a reason why I moved, I changed my job many times.

**Interviewer:** So your degrees were in Control Engineering?

**Kazuhiro Kosuge:** Control Engineering, yes. And actually my supervisor at the Tokyo Tech was Professor Furuta, Katsuhisa Furuta; he is now serving as the President of our Tokyo Denki University and he is still very active in the field and he is one of the pioneers in the area of control theory in Japan and so I learned a lot in some sense, and the education which I received from his lab is really, really valuable for me. I learned a kind of a basic fundamentals concerned with the control theory, how to develop the theoretical work and a very interesting thing, maybe this is a kind of a joke. Furuta means old rice field, okay? And Asada means shallow rice field. Fukuda means fortune rice field. <laughs> And after having served four years and a half, I got fortune and become a professor at the Tohoku University. Yeah, that is my career. <laughs>

**Interviewer:** So there's all the rice fields.

**Kazuhiro Kosuge:** Yeah, I have to cultivate it by myself and that is what I'm doing now.

**Interviewer:** What was your thesis project?

**Kazuhiro Kosuge:** For the PhD it's a control theory. I built up in some sense, I forgot the name. At the time I was interested in nonlinear control theory and my work is a kind of linearization for a class of nonlinear systems by utilizing a nonlinear field work. That is my master thesis. Based on that we proposed a kind of a model following controller for the linear system and together with the linearization brought by nonlinear field work we made a kind of a robust controller which could control the manipulator based on the many different types of sensory information. And that is still I mean I'm still using the results of my PhD thesis for the kind current work.

**Interviewer:** Which manipulators were you using at the time?

**Kazuhiro Kosuge:** At the time, actually it was a long time ago. First manipulator which I used is the – I tried to remember, yes, it's a kind of a prototype manipulator developed by one company that we had a collaboration with the company and they developed a manipulator and so we designed a controller. At that time still we don't have our first computer system and we used Nova from Data General and it is really, really slow. <laughs> And memory size was at the beginning 32 kilobytes and then it extended to finally 128 kilobytes. And so the memory is very limited so we made our own assembly language and our own floating point computational system by ourselves so that we could increase the computational speed. And so I still remember that we tried to increase the computational speed but maximum sampling rate was which we could attain is around I think sampling rate maybe along 30 Hertz or something like that. It was very, very slow. And then after that, that is a time when a first direct drive manipulator was introduced, invented by Harry Asada as well as Professor Takeo Kanade, a group at CMU, and later in some sense we received several direct drive motors from a company and by utilizing that we did several experiments using 2D or 3D planar manipulator system and we did our first control as well as dual-manipulator coordinated motion control dual manipulators using only on the plane, horizontal manipulators.

And then we had another collaboration with an industrial company and we tried, we implemented our control scheme in that industrial robots and we did several experiments. After that we had another collaboration with the industrial robot maker and manufacturer and I think at that time we extended our planar results into real 3D space. So by utilizing two six degrees of freedom manipulator, we developed our single master multi-slave systems. Single master means we developed two joysticks. Each have three degrees of freedom so the total six degrees of

freedom master manipulator could control the twelve degrees of freedom, two industrial robots. And I think that is one of the hardest work relating to the coordinated motion control dual manipulators using real industry robots. At the time, as long as I know only two or three groups are doing this similar work except us. One is Oussama Khatib's work and another one is there is one group in Montpelier, France, Pierre Dorshe's [sp?] group was doing that and I think by through the real experiments using real industry robots we learned a lot and we are confident that our system works for the, could be applied for the real applications.

**Interviewer:** What year was that and what kind of robots were you using?

**Kazuhiro Kosuge:** Pardon?

**Interviewer:** What year was that?

**Kazuhiro Kosuge:** Yeah many years ago. It was just before I visit the United States for one year so I think it was 1988 or 1989. Yes, I joined M.I.T. 1989 so I think 1988. And it's many years ago. <laughs>

**Interviewer:** What companies' robots?

**Kazuhiro Kosuge:** That was supported by Nachi-Fujikoshi Company and at the time we had a friend there. Later he moved to another company so I don't want to embarrass his name. It is a kind of secret. Now he is – actually this is confidential but the guy who supported our research at Nachi-Fujikoshi company is now a kind of what I say one of our I think I don't know how you call it in – one of the managers Fanuc so this part is confidential in some sense.

**Interviewer:** The whole funded part, we won't.

**Kazuhiro Kosuge:** And also of course I had to implement a control scheme at that time. We needed a high speed computational system, okay? We had a very good relation at the time with Sony. We have several friends. One day Sony's guy visited us and he said that they said that they are willing to provide us with a new servo controller system. Servo amplifiers, servo controller systems and each controller could control two axis, two motors. But I told them I am not interested in that joint control systems. We are interested in kind of what to say, a total control so we'd like to control a 360 axis. It was interesting. At that time Sony looks very, very in some sense very active and they are interested in my idea so they told me that they are going to develop a kind of a customized computer system. It's called a bit-slice system so by putting a lot of chips they can develop kind of their own control CPUs. So they developed the CPU

computational system consist of two floating point systems, two FPUs, and one ALU, and several memories or something and the length of the micro-assembler. I forgot the name precisely. The word length is 128 bits. It was really, really powerful. And after that I was Japanese, I am Japanese, so we couldn't know how to give a presentation concerned with this special processor. A similar work was presented in the United States. They call it a very long word instruction something. So I think if we knew how to present it, how to publish the results and maybe it could attract some people. But it's very powerful and it has a capability of a floating point, a computation of maybe at that time 20 megaflops. So now of course now the CPUs are very, very the performance is very high and 20 megaflops is almost nothing. But at that time it's amazing CPU so by utilizing a CPU and together with the Nachi-Fujikoshi's robots and their arm robot system we could realize a single master multi-service systems.

**Interviewer:** You mentioned that you have a lot of friends in industry. How did you meet these friends or how did you make these connections?

**Kazuhiro Kosuge:** Connections? Oh, that's a good question. When I was at the time I was with Tokyo Tech, Tokyo Institute of Technology and of course it's located inside of the Tokyo area and so many people are coming. And actually probably partially they are interested in my research. And partially they would like to support my research. And I have a lot of networks and based on the network I am still doing some collaborative research based on the network which I established I mean when I was at Tokyo Tech.

**Interviewer:** So people were generally visiting Tokyo Tech and then they would also come see your work?

**Kazuhiro Kosuge:** Yeah, because Tokyo is very convenient so as long as we are doing something interesting they can easily I mean visit us and of course my boss at the time Professor Furuta was a well-known professor in the field of control engineering so actually, they are interested in that.

**Interviewer:** What was the first robot you worked on?

**Kazuhiro Kosuge:** First robot? First robot is manipulator as I mentioned but developed by a company and it's a kind of good collaborative research. And they thought that maybe the application at the time control theory is a kind of is called a modern control theory and so they considered that by applying an advanced control theory they could I mean improve the performance of their own robots. But actually we couldn't do it because of kind of a computational burden. The computer system was so slow to implement our own controllers.

**Interviewer:** These were projects that you still did while you were at Tokyo Institute of Technology?

**Kazuhiro Kosuge:** No, no, no, no. Now I've already spent 18 years at the Tohoku University and I have my own network and a part with the network is relating to the network of the kind – which I established or created during my – yeah.

**Interviewer:** When did you first engage the international community of robotics?

**Kazuhiro Kosuge:** International community of robotics? When I was young I was a Research Associate, at the beginning of course I have nothing to present. And after that, it's interesting that at that time linear control theory in some sense theoretical work had been saturated at that time so my supervisor, Professor Furuta, recommended me to do something in the robotics field because at that time robotics is kind of emerging field for the control people so first I start – yeah, the reason why I started the robotics research. And Professor Furuta laboratory itself and they are also doing a lot of research like one is at the time the largest project was is concerned with the – to develop our own computer design system for the CAD for the control system design. And so I am the only one guy who is doing robotics in that lab and that was really good for me because everything, I have to do everything by myself. And nobody knows. Nobody has knowledge concerned with robots so I did everything by myself and that's why it took a long time to get the PhD.

**Interviewer:** When you first got your appointment as an Associate Professor were you working on robots then or were you working on multiple areas?

**Kazuhiro Kosuge:** Okay, Toshio's [Fukuda] field is really, really wide. At that time he when his laboratory he just started micro-machine stuff. Probably at the beginning he was expecting that I was involved in micromechanical system, MEMS, Micro Electrical Mechanical Systems, but unfortunately I had in some sense I had a lot at the time in other fields. So I was involved in both and also so I learned a lot and when I was at Tokyo Tech in some sense I did kind of my research field a little bit limited. And after joining Toshio's group, he is doing a lot of things of course so I have to take care of students, we have to take care of students and each student has his or her own area. So that helps me a lot to learn a lot of different things and how to in some sense how to develop the kind of supposed that you have to do something different. Also in research as long as you are doing research you have to do something different. And so I learned how to in some sense how to supervise students so that he or she could do something different in that field. And that's a good experience, very, very good experience for me.

**Interviewer:** What were some of the projects that you remember from that time?

**Kazuhiro Kosuge:** At the time I think that, it was really a lot. And also my previous sponsor at Tokyo Tech gave me two robots with different controllers. And by utilizing the system I continued the research of the dual-arm system. And that is one of my field. Another one is that by utilizing the manipulator in some sense we developed a kind of a human augmentation, power augmentation system and it's a kind of human-robot interaction, physical human-robot interaction system and I think that still continues in some sense. My most of well-known robots in Tohoku University is the Dance Partner Robot. It has physical human level interaction and the idea came from my experience at Nagoya University concerned with the human power augmentation system. And we developed a very robust and stable controller for the power augmentation. Supposed to like to amplify human's power by utilizing mechanical system then the system interacts with the environment and the system robot interacts with the human, okay? So in order to assure the stability of the system the stability of the system depends on the human dynamics as well as the environment dynamics. So what we did is that by controlling a dynamics of the mechanical system so that it has a kind of it behaves like a tool, a passive tool then we can make sure that the total system is stable. And the stability doesn't depend on the human dynamics as well as the environment dynamics. And that is the idea which we developed at the time and it still works very well.

**Interviewer:** The application would be for exoskeletons?

**Kazuhiro Kosuge:** But unfortunately <laughs> Japan is a kind of over in some sense too much likes too much regulation concerned with the safetyness of robots and so we couldn't bring the technology into the real environment. After that, we are still searching for that in some fields in the future we can apply the technology.

**Interviewer:** But nowadays in Japan for example they have those robot-free zones where you can basically take your robot and send it out and use it in public without a lot of limitations so is that view changing in terms of a lot of safety security?

**Kazuhiro Kosuge:** No still our country in some sense is maybe I should not say that <laughs>. It's very conservative in some sense in a good word, very conservative. Without regulation we couldn't do anything different. So it's a kind of a contradiction. We'd like to develop something different, get something new. But if it was new we couldn't do any experiments using that system in the public. And of course in these ways they have a kind of special rule. If local authority approves it then we can do some experiments but experiments are very limited. I think that is one of the reasons why Japanese, we couldn't produce different robots. In some sense it's over restricted.

**Interviewer:** Where did you get funding for this project?

**Kazuhiro Kosuge:** Which one?

**Interviewer:** The augmented.

**Kazuhiro Kosuge:** Augmentation? Actually we had no funding at the time because we had manipulators <laughs>. At this time I was young so we don't have so much research fund and so the only two robots is a very precious system for me and we tried to utilize the robot for any purposes to prove that our system works, our control system works very well. At the time <inaudible> I stick to the design of the new control system which is robust against kind of this disturbance and everything. Originally I was a control guy.

**Interviewer:** Over the course of your career what have been your primary sources of funding and support for your research?

**Kazuhiro Kosuge:** Actually we have two fundings, three fundings, but in my case of course we have NSF-like research fund. It's JSPS Researching Aid, Kakenhi it's called. And another one is NEDO Project and it's funding for the collaborated research with industries. And third one is purely from industries. At this moment I have many research funding. I have several research funding associates from industries and the amount is larger than that of the government research fund. And so okay there is a reason why I started a more industrial project is that without being involved in the real issues we don't know what kind of issues exist in the real field. And I notice that many people are trying to do some basic research, fundamental research of robotics, but it's not easy to find that new issues relating to the in the field of robots. But in case of the United States you have a very good system DARPA works very well. You have a lot of interesting initiatives like Grand Challenge and a lot of funding is given for the kind of more the other real-world oriented robotics issues.

So in this country researchers I think have some idea concerned with what kind of robotics technology has to be developed for doing for developing anew field. But in Japan unfortunately as long as if you said that this research is relating to the kind of application oriented and then we couldn't get research fund from JSPS as well as JST and something. They believe that scientific research only scientific research is fundamental research and which could be applied to many fields which should be applied to many fields and they fund only such research and so they don't know. Usually it's not easy to notice kind of a real issues existing in real applications. So now I put more emphasis on kind of a collaborative research between industries because they usually bring us a kind of real issues which contains a lot of interesting scientific issues maybe based on through the collaborative research we could establish some new field. That is what I am trying to do at this moment.

**Interviewer:** Have you found it difficult to kind of use that also in the scientific community, the kinds of results that are more application oriented?

**Kazuhiro Kosuge:** Recently – when this will be published? I'd like to know because depending on when this interview is opened sometimes I couldn't say something.

**Interviewer:** It will be at least a year. It will be yeah, not this year. More than a year.

**Kazuhiro Kosuge:** More than a year? Okay. I think for example suppose we are doing some work okay? And then we use both vision and haptic information, okay? And I think we found a very good research topic concerned with kind of the fusion of haptic information as well as visual information. And we are now developing a new controller based on different types of information. So I couldn't say so much at this moment, but I think it's very interesting. The issue came from the industries or through the discussions concerned with some problems which we'd like to solve. We found that we have to develop something different. And I think probably we can develop probably we are going to present it maybe next year. <laughs> I hope.

**Interviewer:** And is this also for a manipulator?

**Kazuhiro Kosuge:** Oh, it's concerned with the manipulator.

**Interviewer:** Sensor fusion.

**Kazuhiro Kosuge:** Yes, sensor fusion. Sensor fusion in some sense.

**Interviewer:** And who have been some of the corporations, industries that have sponsored your work?

**Kazuhiro Kosuge:** It's secret, confidential. I'm not allowed to say.

**Interviewer:** But for your whole career? Have there been others that are not secret?

**Kazuhiro Kosuge:** They don't want to admit it, unfortunately. Very interesting. Of course, if the research was open okay then company people do not want to bring me the real issue. It's all – that's very difficult. Companies in Japan has a different culture. I think I don't know whether it's good or not but they have a different culture. So based on the kind of contract, more strict

contract we can see the real issues. And what we can do is try to I want to say abstract the issue and so that we can utilize the results to many different fields.

**Interviewer:** And then you can publish it basically when it's not related exactly to…?

**Kazuhiro Kosuge:** That's right.

**Interviewer:** Do you think there's a difference in the patent structures in Japan from the U.S. and Europe that make that…?

**Kazuhiro Kosuge:** Patent structure may be the same, I think so. Yes, the same. But the one difference is – I don't know whether I can say but this is true. <laughs> So keep this part secret, in some sense. It's very strange. Okay. Japanese companies they try to get all of the patents which will be produced through the collaborative research. It's not so good. Okay. If our university holds the patents, we can use the patents for different applications. But usually, people say that the company people are trying to keep the patents by themselves. So we are encouraged to sell the rights of the patents to the companies. Actually, we developed several practical systems. We've got patents. And unfortunately our university has sold the patent company so I'm a little bit shocked. <laughs>

**Interviewer:** So you mentioned in '89 and '90 that you went to MIT for a year.

**Kazuhiro Kosuge:** Yes.

**Interviewer:** How did you decided to go there?

**Kazuhiro Kosuge:** Because that is – just after Harry Asada went back to the U.S. and when he was staying at the Kyoto University he asked me whether I can join his group or not. And at that time, it as a secret that he was going back. And yes I got the invitation in some sense. And he's supported my living expenses in Boston. And that's why I joined his group. Again, the data were very interesting. MIT is an exciting place. And yes I learned a lot again. And during – it was only one year but I really learned a lot.

**Interviewer:** Who were the people who were there? And the kinds of projects that were happening at the time at MIT?

**Kazuhiro Kosuge:** Well, I don't remember.

**Interviewer:** Who did you work with basically?

**Kazuhiro Kosuge:** Okay. I was working with the –Harry has his own idea concerned with the robot structure. So we've got – by each rising the drive motor we developed – I don't know the name of the student, but I think probably Kevin. So this part should not be included. <laughs> He may be disappointed that I forgot their names. By using the drive motors which I received from a company another student developed a planar link manipulator system. So my work was, at the time, is how to implement the – I built the control system which could – kind of a master slave control system but using that data to drive motor. And, of course, I was interested in the how to make it the –- how to create different type of intelligent control system but one year was too short for me.

**Interviewer:** Who were some other people that you've collaborated with over the years?

**Kazuhiro Kosuge:** At MIT over the years?

**Interviewer:** Everywhere, Japan and the world.

**Kazuhiro Kosuge:** So it's a difficult question. In some sense I'm doing everything by myself. <laughs>. I was doing everything by myself in the past. And so until recently I think in some sense my research is self-contained. And recently I noticed that the collaboration is very important and I tried to invite several professors in our university. And we are doing something different by converging different technologies. I'm good at the control part of the manipulator, force control or impedance control. It's my favorite area. And some guy from vision join that. And some guy from mechanical design part joined us. And, again, robotics is a kind of product based on the technology convergence. And I like the collaboration with other people.

**Interviewer:** Can you say who the vision and mechanical person were?

**Kazuhiro Kosuge:** I don't know.

**Interviewer:** You're like James Bond.

**Kazuhiro Kosuge:** No, no. I'm not sure, whether I can. Yeah. Because that's related to the kind of confidential projects. At this moment I should not say that.

**Interviewer:** We'll know in a year.

**Kazuhiro Kosuge:** Yeah, hopefully. Yes.

**Interviewer:** So how did you start working on the dancer project? Because you talked a lot about these realistic applications and things like that.

**Kazuhiro Kosuge:** Okay. At the time, when I started the dancer project we are doing some cooperative robot control system, cooperative control of multiple mobile robots handling a single object in coordination. And at the time I was interested in how to make the robot more intelligent. Of course, the definition of intelligence is not so easy. <laughs> So I thought that maybe it might be a good idea to develop kind of a pet robot. So I wanted to develop a mobile pet robot. We named it Mopet. But unfortunately the student who was involved in the Mopet project – in my lab, each student has his or her own kind of research topic. He's been hospitalized for two months or something. So we noticed that we didn't have enough time for him to do something in the Mopet because that is a completely different field from our previous experiences. And so we had a discussion and I noticed that maybe if we created something different, probably I mean that could be appreciated – that could be utilized as a master of thesis, at the time of the student, a master course student. And also through the multiple robot coordination – we are doing a lot of things. Multiple robot coordination and human/robot coordination. And especially the human/robot coordination through the several experiments over a human/robot coordination it turned out that we needed something different for the robots.

Of course, in these days, many people are interested in how to develop a robot assistant, for example. In order to assist a human, for a robot, the robot has to know what the human is doing, what its user is doing, how its user would like to be assisted. Or what kind of a task the guy is doing. And all over the – such information is very important. How, he or she is trying to do, in some sense their intentions. Without this information and the robot couldn't assist the human. Up to the collaborate, I want to say the physical at that time we have a very limited knowledge concern with the human/robot interaction. That's from based on the pure control system design. So we found that something is missing. So we thought it's a good idea to develop a ballroom dance robot. And in case of ballroom dance the male dancer leads the female dancer. So if we could develop a female dancer, we could reproduce the female dancer as a function then probably we could apply the results for the assistant robot for future robots which could assist humans. So this idea combined with the situation of that student and in some sense created the idea of a dance partner robot by utilizing mobile robot. We have several mobile robots. And we decided to use one of the robots. We modify the mobile robot so that it could dance with a human and that is really the starting point. I think it's around 1997.

And, of course, after that we had are doing – the new students continue the research and fortunately in 2005, Aichi Expo provided help in Japan. We gave a proposal for the NEDO project and saying that I would like to demonstrate a dance partner robot. And our proposal was

accepted. And so we could hire the designer. It turned very interesting. A designer of the well-known dance partner robot PBDR is Tatsuya Okonogi who is a real designer, dress designer. And when we found him, we met him, he was one of the key designers of Issey Miyake's group. Issey Miyake is a well-known designer in Japan. And after that he left the group and he's now independent. And so we had a collaboration with the designer, dress designer. And also in order to have a demonstration of our robot during Aichi Expo – actually it was a two week demonstration. It's not so long but it's not a one-time demonstration. So we thought that it was not easy to build everything by ourselves. So we found a company, a generous company to support us to develop the robot. And so the company and it's called Nomura Unison. Now, they changed the name. It's called Nomura Unison and Mr. Okonogi and ourselves set up a group. And Mr. Okonogi has a lot of his own networks. He found a good mannequin company who could produce beautiful outer panel of the robot. And himself a design created a completely different design of a dancer partner robot. And it's really beautiful. And when I saw the first, what I say, we saw the mannequin company which produced the outer panel is located in Kyoto. We are located in Sendai. And Mr. Okonogi is located in Tokyo. And Nomura Unison is located in Chino City in Nagano Prefecture. So four different entities are involved in the project. And, again, we learned a lot. And we noticed that we don't know so much about how to produce something different.

**Interviewer:** How did people react to the dancing robot?

**Kazuhiro Kosuge:** The reaction was so nice. Actually, before that our robot actually a third generation robot was in some sense it was broadcasted. And we had some presentation in the RSJ, Robotics Society of Japan's annual conference. And one media is interested in the robot. And they filmed our robot. And several broadcasting companies broadcasted the robot. Then the other time I was already in Sendai and one of the companies were Sendai they broadcasted the dance partner robot and the original version and newscaster said that she doesn't like the face, the face of the robot. <laughs>

**Interviewer:** Was it at that point the turquoise and the pink one?

**Kazuhiro Kosuge:** No, a different design, original one. Actually, that's the third generation. So in some sense we are disappointed to hear the comments and in some sense discouraged. So this ITX plus project was really nice by inviting the real designer, dress designer. Of course, he's a major designer of dress, he has his own idea, how to make the system, the robot is more attractive to the ordinary people. It's very beautiful. And according to him our robot is a kind of combination of a Mickey Mouse and Marilyn Monroe. I don't know how to pronounce it in the precise way and actress, well known actress. And according to him in order to attract – make the robot attractive to the ordinary people then he said that design should be kind of a combination of well-known characters. He didn't want to make the robot like human. So he include the kind

of design, similar to the Mickey Mouse. It has large ears. And Marilyn Monroe is maybe his favorite actress. So by combining them actually it's very beautiful. And also the first part of the demonstration consists of a solo dance. A solo dance was created by my students and together with Mr. Okonogi. And it was, again, very beautiful. So it could attract many people. After that, actually, of course, we did a demonstration of the physical human/robot interaction. Our student, Dr. Takeda, has danced with the robot. And yeah it was successfully done and many people likes the robot.

**Interviewer:** Do you think that's your most famous robot?

**Kazuhiro Kosuge:** Yes. I think still people know.

**Interviewer:** What about technically?

**Kazuhiro Kosuge:** Technically it's kind of a – I'm not sure whether I could say that – behavior estimation, estimation of the next step, following step based on the resultant force applied to the upper body from the male dancer. And we designed in some sense a behavior, a step estimator based on the – by utilizing Hidden Markov Model and it works. Of course, we are still doing the research, how to increase the robustness or how to make the system more adaptable, adaptive to the different people. Yeah, we found a lot of issues. And actually, during the ICRA Conference, one student, our student, Mr. Hongbo Wang is going to give a presentation concerned with how to realize couple the dynamics of both dancers. It's another issue.

**Interviewer:** What do you think is the biggest technical challenge to this kind of human/robot physical interaction?

**Kazuhiro Kosuge:** Of this interaction? Of course, the different types of – physical human/robot interaction means a lot of different things. So probably they – okay, generally speaking most of the difficult issue is how to create safety, safetyness. The robot has to be safe. So it's kind of issues which we have to solve. But in our case, in case of dance robot several issues, one is how to estimate the human's behavior. This is also general. Suppose that we try to develop an assistant robot, the robot has to know the human's intention, in some sense intention estimation or behavior estimation, more precisely. And the next one is in our case, in the case of dance robot it issues kind of a synchronization of motions or a couple dynamics. So suppose that you would like to do something together with the robot, suppose that you like to carry something like a desk, together with a robot. These two dynamics have to be in some sense have to be coordinated. And sometimes you may need some synchronization. Okay. And another one is – I'm sorry, I'm not well organized. <laughs> And another one is as long as robot is interact with the human – the human may expect some characters, some emotions in the robot. So emotional

behavior, emotional aspects should be implemented in the robot system. That's kind of our final goal. It's really difficult. We are starting with the physical human/robot interaction means that kind design and control first and then try to move it to the in some sense intelligent part. So we are still trying to climb up the stairs, climb up the mountain and that takes time.

**Interviewer:** And is this also funded by industry? Or is this funded by the government?

**Kazuhiro Kosuge:** Which one?

**Interviewer:** The dancer.

**Kazuhiro Kosuge:** Now, of course, concerning dance robot in the past we received research fund from JSPS and also NEDO, the AICHI Expo and the country that we are doing that by ourselves.

**Interviewer:** What do you consider the biggest technical accomplishments of your career?

**Kazuhiro Kosuge:** Okay. It might not be theoretical. I'd like to say based on this human/robot interaction experiments with dance robots we found several applications in the industries. One is PaDY and it's a robot which is supposed to be utilized for the automobile companies, factories. And at least in Japan there is a lot of workers, human workers still involved in assembling of automobiles. And sometimes they have to go back to the workbench to pick up parts and put the parts to the vehicle. And we found that by developing kind of an assistant robot which assisted these workers to assemble the parts, maybe the workers we can make their work more efficient. So our robot is parts and the tools delivery robot. PaDY stands for, it's a bit strange English, Parts/tools-Delivery-to-You robot, PaDY. And the robot captures some parts necessary for the assembly. So the worker is doing some assembly task and then the robot is going to bring him or her different parts. So the robot has to estimate to which extent the work has been done, which parts is necessary for him or her to do the next assembly task or something like that. So it depends in some sense, the concept is completely comes from the dance partner robot which we expected at the beginning.

But some people may be interested in why we didn't develop a home use robot. Because in some sense now many people are trying to develop robot for home use. But home is a really, really difficult environment. We have an older user which means that the robot have to be completely safe. We couldn't educate the user at home. So in case of factories by limiting the kind of – first we can educate the user. The user is a worker and usually are educated for that productions system. And we can control the environment. Of course, it's in some sense it's less unstructured than compared to the home. So I think it might be a good idea to bring the robot

assistant into the factory first. Then based on the several experiences in the factories, probably that concept could be brought into the real ordinary environment. I think we are still working on it. And it's exciting, very exciting.

**Interviewer:** Did it help you improve your dancing?

**Kazuhiro Kosuge:** Pardon?

**Interviewer:** Did it help you improve your dancing, the dance robot?

**Kazuhiro Kosuge:** Yeah. Yeah. <laughs>

**Interviewer:** The student did all of the dancing.

**Kazuhiro Kosuge:** Well, unfortunately I couldn't dance.

**Interviewer:** So who are some of your more successful students who are still working in robotics?

**Kazuhiro Kosuge:** Still working on robotics and successful students? In our case, since maybe since we are doing a lot of system integration type of research and so many people after having got a Ph.D. and many people would like to join the companies. And many students are working in companies. Some of them are developing next generation robots and some of them are doing something different. And concerned with the academia, yes and my associate professor is old student. This is Professor Hirata. And he's trying to apply the kind of physical human/robot interaction technology to the assistive systems, I mean assistive systems of the walking assisted system or other types, usually mainly mobility assistive system for the elderly or some disabled person. I think he's most successful.

**Interviewer:** Can you also tell us a little bit about your work for RAS and RSJ?

**Kazuhiro Kosuge:** Yeah, and the JSME. Somehow I have been heavily involved in society activities. In Japan I was kind of – there are three societies relating to the robots. One is SICE, Society of Instrument and Control Engineers. When I was a member of the board of directors, board of governors, we established a new division in that society, the Society of Instrument and Control Engineers. That division is system integration division. Okay. I was kind of the head of the division and also served as kind of several positions in the board of governors in that organization. And after that I was also concerned with the Robotics Society of Japan. Again, I

was a *riji* [board of directors]… I don't know. I usually remember the English word, but today I forgot the English name.

**Selma Sabanovic:** That's okay. Just member of a board.

**Kazuhiro Kosuge:** Yeah, yeah, a member of the board of the--.

Okay, and concerned with the RSJ, the Robotics Society of Japan, I was also a member of the board of-- a member of the board and I also served as editor in chief of the Advanced Robotics for five years. And okay, concerned with JSME, Japan Society of Mechanical Engineers and I was a-- We have our robotics and megatronics division, and I also served as the head of the division, and of course, before that I was involved in many functions, many roles of running the division. So-- and I think I like being involved in the Society's activities, because it gives me a lot of chance to know something different, something which I don't know, okay? And RAS is also the same. IEEE Robot Information Society it has given me a lot of opportunities to meet new people and to know something different and to catch the-- in a sense to get the information, the most up to date information concerned with the research in our fields. And I also-- When I was only involved in the domestic organizations, what I could get is only domestic. So we didn't know the outside of the country, and now after being involved in the Robotics and Automation Society, I have definitely broadened kind of the information source. So I think that I know more about foreign-- outside of Japan, than the inside of Japan, and so I think that in that sense I like to recommend our young people to be involved in the Society activities at any level. And some people say it's not directly related to the research, and some people, especially in Japan and some of young researchers do not want to be actively involved in the Society activities. But I think it's definitely wrong, and you can brush up your skill to communicate with different people. I mean, this Society is a collection as Professor David Orin, the president told this morning, very diverse and so we could meet a lot of people from a lot different-- I mean, backgrounds and environments, and based on this, we could create a lot of new networks, and that brings us a lot of important information relating to our research, so that's very important.

**Q2:** When did you first become involved with RIS?

**Kazuhiro Kosuge:** That's a good question. I don't remember when. Okay, I think that my first-- I was involved as a editorial board member of Robotics Information Society newsletter. I think that is my first involvement. Of course, the first involvement is to just submit a paper, and paper was accepted, and giving some representations. And when I was a research associate at Tokyo Tech, of course at the beginning, I had nothing to present, and later, I mean, I decided to submit the papers, as many as possible. But of course, we have domestic conference. We also have to submit papers to domestic conferences, and-- But usually I attended international conferences outside of Japan, and I gradually I mean, improved my English skill, and then the

first I mean, the first committee I think it was at the editorial board of a newsletter. It was very interesting, yeah.

**Selma Sabanovic:** What are some of initiatives that you've seen happen in RSJ or RAS while you were there? What are some of the things the societies are trying to do for robotics?

**Kazuhiro Kosuge:** Trying to do for robotics? Okay, concern with SIC. We considered of course, at the time we-- Robotics-- We have a group relating to kind of a technical committee robotics. And it was under the control division. So we thought that-- I think that maybe control division is to now-- I mean, to handle the robotics field. So we established a systems integration division and I'm one of the initiators of that division. And when I was with RSJ and what I did, I don't remember. Okay, and when I was editor in chief of Advanced Robotics, I increased the number of the issues per year, I think from four to eight, almost double. I don't remember exactly. But-- And so I think that it might be a good idea. I thought that it was a good idea to frequently publish the issues. And of course, to do so, we needed more papers. And I think currently they have-- I don't know exactly. Eighty issues? Many issues, yes. I think I'm the first guy to increase the number of issues. Of course, we negotiated with the publisher, and we negotiated with the Society board. And yeah, we had a lot of things to do-- to do so. And at JSME, I don't remember when I did at JSME. And concern with IROS, and from last year we had a dramatically decreased the membership fee. And until recently, every year-- I mean the Society says that they have a lot of surplus. In some sense I'm afraid that as we-- So we visited the budget during the past ten years, and we thought that we could in some sense we could feed back at the society surplus through the ordinary-- to the members of the Society. So we reduced the membership fee from 22 U.S. dollars to a-- We created a new e-membership which contains the electronic subscription, e-subscriptions of the magazine as well as Transaction Robotics, and Transaction Automation Science and TASE-- Transaction Automation Science and Engineering. And it's now, you can subscribe it with a-- You can become a member with nine dollars per year. And actually in some sense, we subsidize each member. And-- But those money comes from the income from the publications distributed thorough IEEE. And so I think that that was my major accomplishment with RAS, and as a result, our current membership is around I think more than 9,000. Last year we had a increase of about 25 cents. It's-- And so I like something-- I like to do something different. And also from this year, and probably from next year, we made a-- We-- Okay, our society has several different kind of committees, okay? Each technical committee has its own activities like a workshop during the conference or some technical committee has its own conference, a symposium or workshops independently of large conferences. Independently have of this ICRA as well as IROS, major conferences of our society. And so I think from next year, based on the kind of this year's financial situation, I think that they can utilize 50 percent of the surplus for the annual activity next year. That is what we approved last year, and implementation is coming soon, and-- But there's-- We did a lot.

**Selma Sabanovic:** What are the venues where you publish the most? Where have you published over the years?

**Kazuhiro Kosuge:** Published? What means?

**Selma Sabanovic:** So conferences or journals? Which places do you send your--

**Kazuhiro Kosuge:** My work? Okay, I'm living in Japan, so in some sense it's a little bit different. If I were living in the United States, of course, everything will be published also in English. But in Japan, some company people do not read English papers, unfortunately. So in our case, first we publish our research results in international conference as well as domestic conference. Domestic conference, as you know-- you may know, Japanese domestic conference is everybody we have known to be in process, but the proceeding has only two pages, okay, and so we usually publish in international conferences as well as domestic conferences, and then a-- if the I mean, if students are good at writing English, we publish in international journals, and some students is not so good at writing in English. In that case, we recommend them to publish the results in domestic journals. So I think that from last year-- I mean, these years, I-- we decided to publish mainly in outside of the country, okay, internationally. Because I mean, I think that based on our-- I mean, my experience, we noticed that there is no border for researchers. So I think that there is very good for opportunity for students to do everything in English. That helps their future. So, and also, simultaneously, I also try to-- I mean now, I decided to accept more foreign students, and we have several foreign students at this moment. And so now I mean, now we try to make our laboratory borderless. We don't want to consider the international. There is no nation-- concept of nation for research. So that is what--

**Selma Sabanovic:** Except for funding.

**Kazuhiro Kosuge:** Pardon?

**Selma Sabanovic:** Except for funding.

**Kazuhiro Kosuge:** Yeah, except for funding. That's a point, yeah.

**Selma Sabanovic:** Where are your students, your international students from?

**Kazuhiro Kosuge:** From? Okay, we have several types of international students. Our university has a kind of short stay, short-time stay like half a year or one year, and also we have--

Some people would like to join the Ph.D. course as well as a master course, okay? And our university started to-- Suppose that I mean, some students came in and he or she couldn't speak Japanese, so we needed some English course. So our department start prepare the English course for those students, and so now many students coming all over the world in some sense. But mainly from Asian countries as well as this year some students are coming from South America, and I don't remember the name of the countries exactly. And yes, for short stay some people we have exchange student from European countries and in the past we accept these students from also a year. And yes, in some sense many countries. But now fortunately, our laboratory capacity is not so large. We couldn't accept all of the students, and so that is my current headache.

**Selma Sabanovic:** How many are you?

**Kazuhiro Kosuge:** How many students? Okay in the university, students join-- select their own laboratory. In our department students select their own laboratory when they are third year of the undergraduate course. So including the undergraduate students, I think we have almost 40 students, and 12 of them-- 12 students are Ph.D. students, and I think the 12 Ph.D. students at this moment I don't know exactly how many master students. Yeah, and I think 12 master students, probably master students and undergraduate students.

**Q2:** What's your recommendation for young people who want to get interested or involved in robotics as a career?

**Kazuhiro Kosuge:** And wants a career? Okay, robotics, I think that suppose that-- I mean, first, okay, robot has just started, okay? Robotics industry has just started. First, the industrial robot was produced-- I mean, was put into the market around 1960. Some researchers say 1961, okay? And it's very young. In the case of automobiles, Ford Model T was started to be produced I think in 1907, I think. And a airplane, Wright brothers flew the air-- Their first flight was carried out in 1903. So compared to the automobiles as well as airplanes, we have a very short history, so I mean, now, the robotics field is-- I mean, tried expanding, okay? And so okay, and this is one fact, and suppose that you try to develop some new type of robots like for example, agriculture robots, for example. Then, in order to-- Robot is a kind of artificially created object, okay? It have to be useful for the society for our field. Okay, so suppose that you try to develop some robot in a different-- in a new field like elderly care, for example. In order to develop a robot, you need a lot from the mentor. You need technologies. You have to design a mechanical system. You need a-- You have to design sensor system. You have to design a controller, and-- But unfortunately, of course, you need maybe you have-- you need certain technology. But unfortunately, by building these technologies, we couldn't develop a new robot. The rest-- There are two types, okay? The rest of the-- It's just like kind of putting a block together to achieve the final function. Something missing. We have several missing blocks, okay? This is a research

topic in that specific area. Or, could be a research topic which we have we-- unknown research topic. Unknown, I mean, basic robotics technologies or which we have to develop for this purpose, and then it could be feedback, feedback to the fundamental-- with the fundamentals. And some technology which is a kind of well-known in technology may not be enough, okay? In order to build a new field robot, you-- Sometimes you have to enhance the <inaudible> technology. So the-- Kind of-- It's a system is integration as well as we need interaction with the fundamental-- robot fundamentals as well as this application field. And so it is very, very interesting. And suppose that the younger guys are-- But it's not easy to start everything from the beginning. So my recommendation is to involve in some-- There are two types. Some fundamental in technologies or some development of some robot. Then, based on the experience, you can broaden your-- I want to say your area and finally, I think that you will be a good robotics engineer. That is what I am expecting. It's very interesting, and we have a center for research and development strategies at the JST, Japan Science and Technology agency. We had a lot of discussions concerned with the structure of robots. The conclusion is the robot is a really huge area which could almost cover all of the engineering field. So I mean, to be our future robotics researcher, you have to-- In some sense you have to know everything. You need a kind of basic knowledge concern a broad knowledge of engineering. And based on the knowledge, you can create your own robot. So it's very interesting, and just started, as I mentioned. So it has a bright future, and I really would like to encourage young people to be involved in this field.

**Selma Sabanovic:** Thank you. Is there anything that we missed or--

**Kazuhiro Kosuge:** No, I don't know.

**Selma Sabanovic:** You're happy?

**Kazuhiro Kosuge:** No, I don't know. I have no idea.

**Selma Sabanovic:** I mean, we've asked the things that we usually ask.

**Kazuhiro Kosuge:** Oh, really?

**Q2:** Yeah, if there's any other big projects you've worked on or--

**Kazuhiro Kosuge:** Sorry, it's a secret.

**Q2:** Any that are not secret?

**Selma Sabanovic:** That are not secret. Right.

**Kazuhiro Kosuge:** Not secret one? Maybe. I think that we are planning to do some demonstration during the next year's IREX, probably International Robot Exhibition which will be held in Tokyo together with IROS, International Conference on Intelligent Robots and Systems. So next year we can say something different.

**Selma Sabanovic:** Great.

**Kazuhiro Kosuge:** I think it should be very interesting. It's the largest project which I have involved so far.

**Selma Sabanovic:** And it is mostly in your lab, or-- Well, you'll tell us later.

**Kazuhiro Kosuge:** Yeah, yeah. No-- Yes, it's a kind of a--

**Selma Sabanovic:** Many different--

**Kazuhiro Kosuge:** Yeah, I asked several professors to join the project. It's very exciting.

**Selma Sabanovic:** Well, we're looking forward to hearing about it when it's open.

**Kazuhiro Kosuge:** Thank you.

**Selma Sabanovic:** Great.

**Kazuhiro Kosuge:** Sorry I couldn't reveal everything.

**Selma Sabanovic:** No, no, no.

**Q2:** No, that's great.

**Selma Sabanovic:** It's perfect. Yeah, no that's great.

**Kazuhiro Kosuge:** Really? Well, thank you very much.

**Selma Sabanovic:** Thank you.