Interviewer: Introduce yourself. Tell us your name, where you were born and where you went to school?

Jana Kosecka: So my name is Jana Kosecka and I was born in Slovak Republic or… <audio skips> in the former Czechoslovakia. And finished my equivalent of masters degree there. so it was the engineering degree in electrical engineering and computer science. And then I came for graduate school to United States.

Interviewer: What university did you go to?

Jana Kosecka: I went to graduate school at the University of Pennsylvania in GRASP Lab. That was the lab I was affiliated with.

Interviewer: Where did you do your undergraduate and masters?

Jana Kosecka: Slovak Technical University in Bratislava, which is the capital of the Slovak Republic.

Interviewer: And why did you decide to come to the University of Pennsylvania?

Jana Kosecka: I was applying for graduate school so I applied to several universities and I got offered a scholarship from the University of Pennsylvania. So that was partially a deciding factor. At that time, it was sort of fairly big laboratory so it was sort of a nice group of people. So there was clear possibility to have a lot of opportunities to work on various things.

Interviewer: And what did you study as an undergraduate?

Jana Kosecka: It was electrical engineering and computer science. So it was kind of a mixed degree at that time. The specialization in computer science happened only in the last two to three years, so it was not just the core computer science. But we also had some basic electrical engineering background. A lot of lectures about antennas and microelectronics and things like that.

Interviewer: And at that point, were you interested in robotics?

Jana Kosecka: No. I was interested in artificial intelligence, in general, so that was the area in which I did my final thesis, masters' thesis. And then at the time when I was deciding to apply for graduate school. I worked as a research associate at the university. So I had a research position. And I was working on some of these more traditional AI systems, expert systems for some diagnosis problems. And I went to a conference. We had a paper. So that was the first time I saw a talk on robotics and that sort of got me interested in the field and then subsequently in the graduate school.

Interviewer: What was your masters' thesis?

Jana Kosecka: Masters' thesis was-- so it was not quite-- let me sort of remember. I don't remember exactly the title but the project which I was working on was some sort of diagnosis of disease in sort of some agricultural application. I don't remember exactly, like they were trying to diagnose some chicken having certain diseases, sort of gathering information about certain symptoms, sort of moderately exciting. <laughs> But this was many, many years ago so at that time, all of these fields looked a little bit different.

Interviewer: So what year was that?

Jana Kosecka: It was-- I mean…

<audio skips>

Interviewer: So you decided to go from the chickens to the robots for your Ph.D.

Jana Kosecka: Yeah. So when I came to graduate it was not entirely clear to me what I will work on but kind of the real world aspect of the robotic systems were very interesting to me.

Interviewer: Who did you work with when you got to the University of Pennsylvania?

Jana Kosecka: My advisory was Professor Bajcsy. and she was the person whose talk I heard so she was a visiting speaker at the symposium in Slovakia when I sort of had my first exposure to some of these robotics problems.

Interviewer: Was there any other robotics going on in Slovakia?

Jana Kosecka: Not at the institution I was at, but there were some people working on controls. But there were other departments. So our computer science department didn't have any researchers working in robotics.

Interviewer: And so you went to the computer science department?

Jana Kosecka: And I went to computer science department. It was called computer and information science department. But the laboratory was a very multidisciplinary laboratory. So there was faculty affiliated from electrical engineering and mechanical engineering. So I also felt it was a good fit because partially my background was in electrical engineering. So I was sort of interested in some of these modeling aspects of systems which sort of the classical computer science or the expert system AI parts of things didn't really offer those opportunities.

Interviewer: Who else was at the GRASP lab?

Jana Kosecka: Lots of wonderful people. So at the time when I arrived, I guess probably it's best mentioned in the connection with people who remained in academia. And so Greg Hager who was a post-doctoral fellow at that time was also at the laboratory. And now he's faculty at Johns Hopkins. Another I think by now famous roboticist who was sort of my contemporary or he was visiting there or he was doing his masters there was Howie Choset. He's at CMU. A lot of people from my generation ended up going to industry. So I'm trying to think my era is also sort of at the boundary of computer vision and robotics because I work in robot perception. So a lot of people who were my colleagues from graduate school worked on computer vision fields. So I don't know, Robert Mandelbaum. Rob is, I think, a program manager now at Lockheed Martin. I mean not a program manager, but he's a head of a division and was previously a program manager at one of the DARPA programs. So that's sort of quickly a few people that come to my mind.

Interviewer: What was your Ph.D. project?

Jana Kosecka: So I worked on-- so this was at the time where, I think, the robotics was sort of undergoing some revolution because this was at a time when Rodney Brooks came up with his first behavior based robot existence. And they sort of generated a lot of excitement and also a lot of controversy because they were sort of very much in the contrary to the popular belief at the time, how a robotics system should be designed. So we with Professor Bajcsy we were sort of very much motivated in sort of trying to understand a little bit the underlying theoretical principles of these emergent systems

which generate this intelligent behavior. So I was working on the design of kind of a formal framework where one could come kind of specify robotic behaviors and then combine them in various ways in order to generate certain sort of tasks and also be able to prove some properties that this task will be accomplished in a safe non-conflicting manners and the goals will be achieved. So the field was-- I mean the work was the inception of at that time of this emerging field of hybrid systems where we're basically trying to model the behaviors using automata theory but the behaviors within the individual states of the automata were modeled using the differential equations. And we were trying to come up with some analysis tools in order to be able to predict the behaviors or prove some properties about the systems.

Interviewer: What were the big challenges to that sort of research at the time?

Jana Kosecka: Well, so the big challenges I think were both theoretical and experimental. You know, at that time everything was incredibly slow. And the domain in which we were trying to apply these techniques was visual navigation and tracking and landmark based recognition and so forth. And so being able to do experiments robustly and reliably with, I guess, with the state of the art cameras were at that time there were no digital cameras. We have this like huge digitizer boards and everything was slow. And the robots were sort of not so readily available so we had sort of various mobile platforms where we were doing sort of these experiments. So that was a challenge to demonstrate that this actually works robustly. But also, I think, theoretically it was sort of not obvious how to do it. so it took some time to kind of choose the right set of problems where we can actually design the techniques and analyze the behaviors.

Interviewer: What sort of robots were you using?

Jana Kosecka: Oh, we had this-- we just had this omnidirectional-- well a couple of them were omnidirectional mobile platforms where we just mounted various sensors on it. And a couple of them were just differential drive robot. So just mobile robots with sensors. Mostly cameras and structured light sensors.

Interviewer: And when did you finish your Ph.D.?

Jana Kosecka: I finished in 1996.

Interviewer: And what did you do from there?

Jana Kosecka: And so then I went to-- I got a post-doctoral position at University of California in Berkeley. And so after that I initially wanted to start working on an autonomous driving project because that had sort of some of those characteristics where we had kind of visual sensing and some control components. So we worked on this was kind of a first federally funded project for sort of automating the highways. And there were lots and lots of teams involved and it was a kind of great fun project because we got to drive in these autonomous cars. And there was like a big show at the end kind of demonstrating the feasibility of some of these concepts. And it was also kind of fun team project. And it had both some engineering challenges but also some kind of technical challenges in terms of how to design the techniques and algorithms. And then I stayed for two more years. so this was just the first year of the post doc. And our team kind of entered the game very fast and we got the car from Honda with the two Honda engineers. So we managed to sort of kind of very quickly get up to speed and have basically a working system within the year of a car which can change the lanes and keep a safe distance from the car in front of you just using visual sensing. So we had sort of cameras mounted behind a rearview mirror. And we also got to learn how to have some sort of emergency driving maneuvers for safety reasons which was kind of fun because we had to go for this training for the racecar drivers. So there was, again, an extra perk which was part of the project. And then I stayed on and ended up working a little bit more on the perception aspects on visual sensing as applicable to broader class of problems not just these problems where vision is in the control loop of a system, of a robotic system.

Interviewer: Who were some of the people that you collaborated with?

Jana Kosecka: So at the driving project so that first year the two post-doctoral advisors were Professor Jitendra Malik who was the computer vision faculty. And Professor <audio skips> who was a control faculty. And I worked with C.J. Taylor who is now a faculty at the University of Pennsylvania. And Phil McLaughlin who was a former graduate from Oxford but then he went on and sort of ended up working in some special effects company for movie industry and advertisement. So these were the two other people in the project.

Interviewer: What were the perception projects that you worked on?

Jana Kosecka: So at the time-- as a post doc I was sort of halfway in the computer vision group and half way in the control group. And being in the control group there were a lot of people who were interested in vision problems. And so we started revisiting some of these, I guess, at that time seemingly well-defined problems of kind of computing motion and trajectories from image sequences. So this is this well-known structure from

motion problem. And then subsequently the 3D reconstruction problem. So myself, Professor Sastry and another graduate student, started to looking at these techniques and then we came up with some new insights which use some tools and techniques commonly used in control theory. And sort of very formulated some of these problems in using more linear algebraic techniques as opposed to projective geometric techniques which were sort of dominant at that time in computer vision and managed to come up with some new sort of well performing algorithms. And so that sort of, again, generated a lot of excitement. And sort of led to several other projects which other students ended up working on for say autonomous helicopter landing and control. But then these techniques were also applicable to completely general settings where you can just take say handheld video camera and you can compute how the camera moves and also recover the 3D structure of the environment. So we kept on working on this for sort of quite a few years. And that part of the work led to a monograph. So we wrote a book which sort of ended up also being a commonly used textbook in the field for this class of geometric problems.

Interviewer: What was the title?

Jana Kosecka: "3D Vision from Images to Models" but I just want to make sure that I'm not omitting some word. Yeah.

Interviewer: And so then what did you after <inaudible>.

Jana Kosecka: So then I was there for three years so it was a long post doc. And so then I started applying-- so at the time when I started post doc I was not sure whether I want to be in academia or go for an industrial position. But the experience was so wonderful so I decided that I would like to apply for academic jobs and that's what I ended up doing. And I was not applying very broadly but I sort of wanted to remain at one of the coasts. So I had some geographical constraints at the time. And so I ended up getting a faculty position at George Mason University.

Interviewer: Was there anybody else working on robotics with computer vision?

Jana Kosecka: So there were no faculty working in robotics but there were a couple of other sort of more senior colleagues working in computer vision.

Interviewer: What sort of research were you doing when you got there?

Jana Kosecka: So when I came I ended up continuing a little bit in using these techniques which were developed which were very general techniques and trying to understand how can we make them more robust if we exploit some constraints of specific environments where these techniques are applicable. So we made sort of several variations and improvements focusing on deploying these techniques in manmade environments where you have a lot of planar and orthogonal structures. So I ended up working quite a bit on the localization problems, mapping problems, structure recognition problems in these environments. And then more recently we also started to be interested in doing some research in recognition and segmentation problems.

Interviewer: Were you primarily focusing on the vision aspects? Or are you still using some robotic platforms?

Jana Kosecka: So I think I have been primarily focusing on vision aspects but I was trying to choose the problems where the solutions would be actually relevant for robot perception. And those choices were made by making some conscious decisions of what kind of data we use, how we acquire the sequences. So-- and then we also did some experiments with mobile platforms, but in that first stage or-- right now we are sort of investing a little bit more in sort of the hardware infrastructure. But we were mostly focusing on kind of working with the videos and images acquired by robot platforms but have not done as much in the control aspects as before.

Interviewer: Anything with regard to the interaction and its relation to perceptions or using the movement of the robot to <inaudible>.

Jana Kosecka: Yeah, so I found it a little bit difficult to work on the control aspects because now my position was at the computer science department as opposed to before I was at the computer science electrical engineering department. So it was very difficult to find students who have the right kind of background to work on it. While before I had sort of a little bit better background for my undergraduate and also graduate studies being in the lab. So this was also partially related to the decision of focusing on the problems which did not require such a heavy control component partly because the students who I was working on didn't have the right kind of background. And our electrical engineering department also didn't have sort of the right type of collaborators to really fully pursue this. But I think this is changing so I feel that I'm kind of moving a little bit closer to looking at some control problems and, I guess, being better equipped also. So we know now how to do the perception side a little bit better. So hopefully we can close the loop.

Interviewer: So I saw that you're a recipient of the David Marr award. Do you have a perspective on the ecological perception versus the three dimensional reconstruction project?

Jana Kosecka: Well, the award, the work which we got the award for was very geometric. So I guess in Marr's philosophy of how computer vision is structured into sort of levels and set problems it really focused mostly on issues of how to recover the 3D information. I think everything is important. I think vision is a very complicated sense and we use a lot of different cues how to interpret things. And we are incredibly good how to combine these different cues and priors on the tasks and environments of how to solve these really highly ambiguous problems. And I think we are still quite far from being able to develop systems which replicate some of that functionality. So I think both aspects are important, the ecological definitely so.

Interviewer: Who are some of the people that you collaborate with on these projects?

Jana Kosecka: So I collaborated quite a bit with my former colleagues from the post doc times. I had some collaborations on the vision side also. So this was mostly Yi Ma and Professor Sastry and Stefano Soatto who were my co-authors in the book. I had some collaborations Hany Farid from Dartmouth. He ended more sort of working on purely vision and image processing aspect. And then the majority of the work I sort of ended up doing with my students afterwards.

Interviewer: Who were some of the students that you worked with?

Jana Kosecka: I had I guess a couple of Ph.D. So I had Wei Zhang who was a Ph.D. student. Both of them ended up going to industry. And he worked on some of the kind of manmade structure recognition problems. I had another student who we worked on some of the object recognition problems. I had several wonderful post-doctoral fellows. So I had a post doc from Slovak or Czech Republic who worked with me for several years. His name was Brani Micusik. I mean he's one of my co-authors, so it's easy to trace down. He ended up going to kind of a research institute in Austria. I had another post doc who worked with me recently on the semantic segmentation problems. This is the Cesar Cadena. And he moved on to be a research associate in Australia in one of these national universities. I had also sort of quite a few visitors which came for a shorter period of time. Ana Murillo was a great collaborator. We worked on a lot of the localization problems together. So these were sort of my known student collaborators who have spent extensive time together. I also did a very long sabbatical. <laughs> So I had some successful collaborations during that time as well.

Interviewer: Where were those?

Jana Kosecka: After my tenure, I got sort of visiting researcher position at Google or visiting faculty. And so I worked on the street view project at the time where there was no street view product, yet. So I was sort of involved and helping out a little bit to get some of the initial prototypes up and running because that project sort of very directly related to the expertise of sort of taking sequences of images and registering things and computing the trajectories of vehicles. And so I worked on the project for a year. And then I had some sort of consulting position at Nokia Research Lab where we were also sort of interested in these problems of how to use all of this data which is collected by companies which built maps. So Nokia has their own map building subsidiary which is Navteq. And we were sort of interested in how to kind of develop tools and techniques which can help pedestrian in pedestrian zones navigate better and sort of give directions maybe to visually impaired. So there is sort of this central team of sort of understanding these manmade structure environments and how to localize and recognize and recovery 3D structure of them which was, in a way, common to many of these projects. And then the rest of the time I was spending as a visiting faculty at Stanford. So I was teaching a class and working with my post doc and visitors. I took one of the students with me.

Interviewer: Were there any other people who you collaborated with?

Jana Kosecka: So yes, I collaborated with Christian Theobalt who was sort of a vision/graphic person. He was sort of interested or we were sort of collectively interested in motion capture. So this was kind of a set up where you have multiple cameras, where you can record both the 3D depth and video. And we were interested in recovering 3D motion using some of these 3D construction techniques we had some experience with. And Sebastian Thrun was also partially involved in that project although at that time he was also partially on leave but Christian was sort of his visitor or collaborator. So we had some common students and interacted a little bit. And then I had some collaborators in Nokia, so we have written a couple of papers with Radek, very hard to pronounce last name, Grzeszczuk and some of his teammates.

Interviewer: So over the course of your career, where have you typically gotten funding for your research projects?

Jana Kosecka: I was very fortunate to receive some NSF funding early in my career so I got sort of couple of NSF grants. I got the career award which was sort of wonderful start. And I got another grant on sort of this visually guided control and sensing. I have-- so that was sort of the pre-tenure funding sources. And I had a couple of smaller grants from the university. And since I came back we continue some of the work on sort of the semantics

and understanding which was supported by army research office, ARO. And then some of the vision work has been supported by IARPA. National Geospatial Agency, NGA, also supported some of this work. So these are sort of the main sponsors.

Interviewer: Now, what's been your view of the relationship between the robotics community and the computer vision community?

Jana Kosecka: So I feel they have been for quite a few years, for many years kind of quite divided. And I always sort of try to keep one of my feet in each of the communities. But I think they're starting to sort of reengage a little bit because there have been lots and lots of advancement in computer vision which I think the robotics, problems and systems and community can really benefit from. And that creates both challenges and opportunities because the settings in robotics are a little bit different usually. So that's, I guess, an opportunity because certain things could be done better, more reliably, but then there are also challenges because we have time constraints and one needs to sort of choose the right task. And then also the challenges are the type of data you encounter in robotics I think is often not the type of data you encounter when you analyze general photographs which are taken by photographers, from canonical viewpoints. So there a lot of biases introduced just right away how people take photographs which are the main source of data computer vison people analyze, which do not exist in robotics setting. And so how to kind of close the divide and sort of develop systems which sort of perform well and are robust.

Interviewer: But you're seeing deeper engagement these days?

Jana Kosecka: I think because I think people in robotics are, first of all, excited about the advancements that a lot of things are starting to work really well. Also, I think, the technological advances which are kind of facilitated by these GPUs and sort of being able to implement things much faster are also very exciting because the techniques which could not be conceived previously to be run in a robotic setting can suddenly run in real time. So I think both of those sort of level of problems but also the level of technology I think there is a lot of communication. And I also-- it's a sort of emerging also at the level of sort of people trying to sort of visit the respective conferences, organize workshops and have discussions of what are sort of the common problems where both communities can engage in.

Interviewer: And what are the big challenges and common problems going forward for the robotics <inaudible> intersection of the two?

Jana Kosecka: So I think so the detection and recognition of objects and human activities it's still so very challenging. And I think in computer vision people are more interested in trying to make some headway in say trying to parse YouTube videos or other sort of depositories of videos. In the robotics setting it is of importance in the context of human robotic interactions and understanding human intensions. So both the goals are different but also the environment where these videos are taking are different. And so there are different challenges. And the same for object recognition and detection. I think in robotic setting you have a big difference because you have this capability of moving. You can move your platform, change your viewpoints, while in computer vision setting you typically all you have is that one image which you are trying to understand and you really have no control of your sensing capabilities. So that's sort of what we are currently excited about.

Interviewer: Can you tell me a bit about your work with the IEEE Robotics and Automation Society? And how you became involved in the robotics community?

Jana Kosecka: So I have been mostly involved sort of at the level of kind of reviewer or conference organizer, workshop organizer and program committee member at various levels. I'm also the chair of sort of the computer vision robot perception sort of area, the robotics and automation societies, the technical committee for this area. So these are mostly my levels of involvement. So we are sort of trying, I guess, promoted the field and also keep people informed to what's new and what people are doing and what are the new exciting and interesting problems.

Interviewer: And you're also part of this historic all women organization.

Jana Kosecka: Yes, I guess, I am partly because yeah I have been in the field for a while as you can probably easily count. <laughs> And yeah so I think it's really exciting that we have sort of sufficiently large body of women who are sort of strong and motivated.

Interviewer: Do you think this is going to help increase the participation of women in robotics? And what are the challenges in doing that?

Jana Kosecka: This is, I think, a very tough question. I think my personal view of this is that this is clearly related to a much broader problem of sort of engaging not just females but students in general in the STEM related fields. And having my children in school now I feel that the problems should be addressed, actually, much earlier than at the level which they are being addressed. I think high school level, middle school level I think it

would be great if students can get more exposed to these fields. And also I think there are a lot of opportunities to kind of change the way how the science and mathematics is taught as sort of this introductory levels.

Interviewer: How would that change more?

Jana Kosecka: I don't know. I came from a very different educational background and that background was very effective in preparing me well for the career which I have. And I think it's hard to attain such a level of preparation. And my background was in no way special. I mean everybody could sort of attain that level of preparation. And I think it's just harder to attain just the way how the school systems are structured. I mean there are some sort of fantastic institutions which devote a lot of effort to these things. But I think it sort of takes a lot of involvement of individuals and parents to follow through. And so, I think, it's much easier, you may have a lot of talented children which just fall through the cracks because of the system and I think it's difficult.

Interviewer: Do you think it's a need for more say rigorous mathematical training? Or do we need more of these kind of robot challenge?

Jana Kosecka: I think both. And this is, you know, I have a very small sample, set of observations but there is a huge emphasis on language arts and much less emphasis on kind of repetition and training. <inaudible> these things have to be really done at a young age. I think it's hard to catch up when you are not young. Because, you know, when the more complicated topics come around there is just no time to think about simple things. You have to just-- you just have to have it in your system.

Interviewer: So a question we always ask is what's your advice to young people who are interested in a career in robotics?

Jana Kosecka: I think it's try to be good at math. I think it's great if you know how to program and also sort of be good in system development. But I think everybody should just follow their dreams. I think if you're persistent you can sort of overcome the obstacles. But I think it's also very important to have the right kind of guidance, you know, to be able to choose the right problems such that you can kind of learn along the way and become more independent and such that you can formulate your own problems and lead them to successful solutions. And I think they should just seek mentors and get involved in projects which are well defined and especially at sort of this younger age. I'm saying that because I work with some undergraduate students who are sort of interested. And

it's sort of eye-opening. I think any kind of experience of getting involved in some projects early on is extremely valuable for them.

Interviewer: And have you kept track of the developments of robotics in Czech Republic?

Jana Kosecka: Well, mostly, I have mostly through sort of the regular new channels. There have been very exciting recent developments where sort of a team or a company of these Slovak engineers joined some forces with some artists and they came with this first flying vehicle. There was a big, I guess, a lot of news surrounding it but I think it happened sometime in fall. And I think a nice example of this is that it was a joint collaboration between artists and engineers. So I think that capability of imagination and dreaming is sort of extremely successful in coming up with new solutions and thinking of new problems. And that, I think, it's very important to have this kind of wall around it education as long as you have. So I would not recommend just focusing super strictly on some very narrow area because I think it's kind of easy to get lost in sort of technical details without sort of being able to see bigger picture and imagine sort of new opportunities. Because a lot of these very successful researchers are the way because they're very creative and they can think of new problems and possibilities.

Interviewer: Is there anything that we missed that you'd like to talk about?

Jana Kosecka: Nothing. I think it's just a wonderful field. I'm really happy with the field I chose because it's-- I think it's quite like it will not run out of problems any time soon which is great. And I think now it's also sort of a good time because some progress is being made. I mean there were these periods where there just a lot of false promises and no deliveries. But I think it's changing a little bit partly due to the fact that we've learned a lot but also due to these technological advances. That we can do things which we could not do before and they're making a difference. So that's all.

Interviewer: Okay. Thank you.

Jana Kosecka: You're welcome.

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