Rashmi Mohan:
This is *ACM ByteCast*. A podcast series from the Association for Computing Machinery, the world's largest educational and scientific computing society. We talk to researchers, practitioners, and innovators, who are at the intersection of computing research and practice. They share their experiences, the lessons they've learned, and their own visions for the future of computing. I am your host, Rashmi Mohan. What you see is what you get. And yet, what if you could see much faster in greater detail, and just a whole lot more than what you do today?

Rashmi Mohan:
Our next guest is a visionary, pun intended, in the field of computer vision and computational healthcare. Ramesh Raskar is an associate professor of computer science at MIT and the head of the MIT Media Labs, Camera Culture Research group. Amongst many other accolades, he received the Lemelson-MIT Prize in 2016 and is a renowned speaker. Ramesh, welcome to *ACM ByteCast*.

Ramesh Raskar:
Thanks Rashmi, how are you?

Rashmi Mohan:
I'd like to lead with a simple question that I ask all my guests. If you could please introduce yourself and talk about what you currently do, and give us some insight into what drew you into this field of work.

Ramesh Raskar:
Thank you, Rashmi. My passion is to make the invisible visible. It has to be magical to make it interesting. A lot of my earlier work has been in looking at computer vision and imaging to build cameras that can see around corners, or build medical devices that can see inside the bodies in unique ways. Nowadays, I'm also focusing on how to make the invisible data visible. Looking at how can we do machine learning that's privacy preserving for health.

Rashmi Mohan:
Got it. And as a young computer engineer, when you started out, what really attracted you to this field Ramesh? There were so many different options to pick from when you sort of first graduated from college.

Ramesh Raskar:

Yeah. I mean, I got into the whole field of computer vision, camera graphics because of the movie Jurassic Park. I said, "Wow, these dinosaurs. It's just amazing to see them on big screens." And so I went to UNC Chapel Hill, North Carolina, which is the number one school in computer graphics.

Ramesh Raskar:
But near the end of my graduate school, I saw South Park and I said, "South Park has pretty much no computer vision, no special effects, but it's probably as entertaining as Jurassic Park." That was kind of a downer. I had the classic South Park versus Jurassic Park moment. And what I realized is that the functional aspect of what we do is so much more than just the pure visual aspect of it. It's not just the special effects, but it's also the story and what happens behind it.

Ramesh Raskar:
And when you kind of think of that in reverse, I realized the ingredients, and how they come together are so much more important than how the polished presentation is at the end. And so as a fundamental science, I think that's always an important question. Should you be driven by great ingredients and great tools, or should you be driven by the final product that you deliver? And over time, I have realized that what really matters to me personally is building tools.

Ramesh Raskar:
Building these magical tools that creates something that's seemingly impossible. And when someone looks at it says, "How did you do that?" And then I get the pleasure of exploring what the underlying tools are doing. Whether it comes to computer vision, or computer graphics, or digital health, the underlying tools that I have been using are roughly the same, which is imaging, computer vision, machine learning, and so on.

Rashmi Mohan:
Got it. Yeah. I can understand. I mean, *Jurassic Park* and *South Park* polar opposites in terms of content. What is interesting to me as I was doing a little bit of research as well, and maybe this is just my perception, but it seems that computer vision, as a field of research, seems to have gained a lot of popularity in the last few maybe decades.

Rashmi Mohan:
What do you think caused this spike or this interest? Was it a certain innovation, or a certain need that really sort of drew people into this field of research?

Ramesh Raskar:

If you think about human intelligence, I would say computer vision is for the most challenging problem. If you just look at the human IO, our seven senses, the visual sense is the most important of the seventh senses. But when it comes to output, the humans are actually pretty terrible at high bandwidth output. It'll take us forever to draw a diagram to explain to somebody or to explain what I believe, what this all means, or to gesture, to explain a scenario. It's like playing dumb charades.

Ramesh Raskar:
Humans are terrible at output and we are okay at input, and for the best input is the visual input. So even in terms of human intelligence, computer vision plays that role of seeing the world.But of course, the challenge is that we don't see with our eyes. We just record with our eyes and see with our brain. Computer vision is really a fusion between how our eye and how our brain works together. And so I've been fascinated with both aspects of it.

Ramesh Raskar:
How do you create a new eye, and how do you create the new brain for visual processing? To your question about the importance of computer vision, I think we'll continue to grow. For the first 30, 40 years of researching computer vision, the emphasis was on a very model driven techniques. And thanks to new data driven techniques with machine learning and newer Solomon inverse problems, we have just seen just a tremendous growth in how we think about computer vision and how we solve the big societal problems with computer vision.

Rashmi Mohan:
That's really great to hear because obviously there are so many more problems to be solved and new researchers coming into this field have a lot of exciting things to sort of crack open. One of the things that I want to touch upon is the fact that you were talking about data, right? There is a proliferation of images and videos now, tons of data available for anybody who's trying to solve problems in this space. What's your take on that is it a good thing to have that kind of data to be able to sort of feed your models and get more accuracy, or are there financial or environmental costs associated with cleaning this data and processing it?

Ramesh Raskar:
Yeah, I mean, any AI machine learning project has three parts: capture, analyze and act. And for the longest time we thought the analysis, the computer vision problem itself is probably the most exciting. And then we actually realized the first part, which is how do you capture the data and how do you act on it is also equally important. And so previously capture was with standard RGB cameras or very small data sets. And now we can see a whole industry, a whole research

field has come up and how do you even capture the data? So just creating data sets, creating new types of cameras that can record the world in new ways that has exploded significantly. And then also, how do you act on the analysis you have done, as you can see, whether it's self-driving cars or AR, VR or medical imaging, what do you do with that?

Ramesh Raskar:
How do you make it actionable? Has also become a very interesting research problem, but yes, I mean, it has lots of downsides when it comes to data, there are issues with privacy. Issues with ethics and bias. When it comes to its analysis, the environmental factors like you said. There are financial costs. There are also issues of, is this a winner takes all? I know the interior that has more data and more resources will leap ahead.

Ramesh Raskar:
And especially folks who are live in low-income and middle-income countries, will they ever be able to catch up with this? And the same thing with act the ethical issues, in how do you make that analysis actionable. Is that going to lead to job displacement? Is this going to make all of us very dumb and are we going to lose a whole generation that understands the fundamental physics and principles behind all these activities? Or are they just going to create data driven models, kind of data in data out black box models? So, yeah, there are a lot of underlying questions that we need to tackle as we shift away from it kind of a model based kind of rule-based computer vision and machine learning to something that's more data driven.

Rashmi Mohan:
Got it. Yeah. No, thank you. You bring up an excellent point. I think as we consider these new areas of research, we must be looking at not just the great advantages that we get from it, but how do we do this? How do we conduct this research in a way that is fair, that is equitable across all of the various lines that we have drawn societally speaking? But I'd like to sort of dig a little bit deeper on the point that you were bringing about capturing data, right? Many of us have seen and been completely wowed by your video of light traveling through a plastic bottle. I know I've seen that video multiple times. So your work in femto-photography is super exciting and we'd love to hear your journey through that area of work. And how have you seen that evolve?

Ramesh Raskar:
Yeah. Certainly, as I said in my passion is to make the invisible, visible. Any research we do has to look magical and when it comes to this camera that can see around corners, I was very inspired by some of the work from people like Steve Seitz and kudos Kurtholokos [phonetic 00:09:10] , at State of Washington and Toronto respectively on inverting transport by observing

light in the scene and figuring out things about the scene, all about the light. And I was very inspired by that work in 2004, 2005. And with my colleague, James Davis at UC Santa Cruz, I said, "I have an idea of what we can do with extremely high speed imaging." And at that time Jim's had some other ideas on what you can do in terms of 3D scanning with extremely high speed imaging. And I said, "Maybe we can build a camera that can see around corners."

Ramesh Raskar:
And Jim said, that's too challenging. So I ended up talking to a whole bunch of people all over the world who know something about this and I'm not a physics person. So it took me a long time to understand the underlying physics, the underlying quantum theories and so on. But eventually with my postdoc, Andreas Velten, who is a faculty now at University of Wisconsin in a variable to build a system and Rashmi as I said, he sort looked at that video so many times and every time I looked at the video, I appreciated it, but always found some foul. I was like this doesn't make sense. That doesn't make sense. And I would always have an argument with Andreas, my postdoc at that point. And Andreas would say, "I don't know this is raw data we captured. So what are you talking about? It cannot be wrong. The physics cannot be wrong." And what we started realizing is that there are all these amazing spacetime effects that you can observe when it started recording at this femtosecond picosecond resolution that are just counter-intuitive.

Ramesh Raskar:
And so we can take all that information and invert that and infer things that were the scene that, as I said, just seem are magical. So that's kind of the root of that whole project. Originally we thought we going to build a camera that can see around corners, but in reality, once we can image the world at femtosecond picosecond resolution, then we can do so much more we can create new medical instruments that can see deep inside our bodies without x-rays, there's a new NSF project we have, a moonshot project, to create five micrometer resolution at five millimeter depth inside the body.

Ramesh Raskar:
So that's in collaboration with CMU and Rice and Harvard and some other universities. And we can create cars that might avoid collision of what's around the bend. We might be able to create solutions for firefighters to find survivors in hazardous conditions. So from a micro scale to room scale, to very large scale, we can use this extremely high speed imaging to see the world in unique ways.

Ramesh Raskar:

And we have all seen those, let's call them medium speed video shoots, where you can from Doc Edgerton kind of bullet to an Apple or all these TV shows that can smash things. But then they're only going at 4,000, maybe 5,000 sometimes tens of thousands of frames per second. But when we call to roughly 1 trillion, not a million or a billion, but 1 trillion frames per second, the world really opens up. And the exciting part is once we have this new way to capture again, capture, analyze, act. Once we have this new where to capture, we can analyze and act on this information in completely unique ways. So our dream is to create a new field of computer vision that defines what a camera means, because if we think of a camera of recording what you can see in front of you, but if you can see what's around the corner, then all the rules of computer vision get rewritten. And so we're very passionate about creating a whole field of computer vision about things that you cannot see.

Rashmi Mohan:
It sounds like you said magical. It sounds like a blue sky project somewhere far out in the future and especially because you're saying we'll be able to see things that currently the human eye can't. I can't see around the corner and you're going to enable me to do that. How far do you think we are from this actually being out on the streets Ramesh?

Ramesh Raskar:
Ten years ago I thought, "Hey, it's only 10 years old." I started the project 2007, so it's been 13 years. But if you see the latest SPAD cameras that are in the latest iPad and iPhone 12, and I'm sure you'll see the same thing on Samsung and other high-end smartphones, the underlying technology now is available at consumer form factors, not at the same resolution, not at the same sensitivity, but they are here. And even if you think about lidars on self-driving cars or autonomous vehicles, they are reducing the cost from tens of thousands of dollars to below $10,000 now.

Ramesh Raskar:
So the underlying pieces of the puzzle are actually already here. And algorithms from my team and my former group members who are now faculty at some of the top universities, and of course, a large DARPA project that was sponsored based on our research, a program called REVEAL, which is a $30 million DARPA program that was launched partially inspired by our work. Those $30 million have really taken the field to the next level. So Rashmi, I mean, we are, I feel really close. I wouldn't say 10 years anymore. Maybe we are two or three years out to see robust, at least bench-top solutions to see around corners for industrial applications, medical applications in the beginning and maybe in five years consumer applications.

Rashmi Mohan:
That's incredible you know Ramesh. So, I mean, I was doing a little bit of research about your work in preparation for this conversation. And one of the things that struck me is how much of your work is relevant and something that is impacting society in a way that is tangible. And it's something that is closer and meaningful to us. I know that you've also been doing work in these times, in this pandemic times, helping with COVID-19 contact tracing. And I'd love to hear more about that as well. I know it may be a little bit of orthogonal to the traditional work that you're doing, or maybe not. I'd love to hear more.

Ramesh Raskar:
No. Not at all. As I said my whole life and my whole research direction is all making the invisible, visible. Whether it's invisible object or whether it's invisible data. And so the problem that we have been tackling for the last seven or eight years is this notion of invisible data. And the idea that if you magically have a God's eye view or a bird's eye view without making it too religious of the world, let's take the example of health. Let's take diabetes.

Ramesh Raskar:
If we know every person who is diabetic, you know what their genomics, what their environmental behavioral socioeconomic factors are, what treatments are working, what lifestyle changes are helping and so on. If we have this bird's eye view of every person who is diabetic, one could argue that we can create the Waze for health. It's like when you're using this traffic navigation app Waze from Google it shows all the other people who had gone from Boston to New York, what route they took and whether it worked out for them, or not more importantly, if I start right now from Boston to head to New York, what are some challenges along the way.

Ramesh Raskar:
So Waze makes that invisible data visible to me by sharing with me in real time, what has happened all the people who are ahead of me from going Boston to New York and a diabetic person should also get this dashboard of what would happen if they took every action and that could motivate them, that could give them the right advice at the right time and so on. So one could argue that many, many, many health problems can be solved overnight if we have complete visibility on everything that's going on in the health ecosystem. But the challenge is folks don't want to share their data because of privacy or regulation or trade secrets. Sometimes even national security. And because of that, the data remains invisible. So we have this classic trade-off between privacy and utility. When it comes to Google maps and Waze maps, we have very little privacy.

Ramesh Raskar:
We willingly give away over location data, and we get great utility, which is traffic conditions. But when it comes to health data, we have the opposite, which is we are not willing to share our data because of privacy. And we get very little utility out of it. We just have to believe what our hospitals are saying and what our doctors are saying or what the research that's conducted on 50 or a 100 patients is saying. So we have this kind of a dichotomy between privacy and utility of the data, but it's a false dichotomy. And when it comes to COVID-19, when the cases were going up in China and Korea in February, I said, "Why don't we do this in the U S? Why don't we create this bird's eye view into everything that's going on about people's interactions?" But at the same time, do this in a privacy preserving way so we can get both privacy and utility.

Ramesh Raskar:
So we launched the nation's first contact racing app back in March, we also publish the first algorithm, decentralized privacy preserving algorithm, in mid-March and it has been great since then, the pandemic is just awful, but it's also wonderful to see communities come together to work on this very important problem of privacy preserving solutions for public health. So that's kind of our effort and just today, we launched our app in Minnesota and we are in five US States and three nations you'll hear about them very soon. So on one hand the pandemic continues to create challenges. On the other hand, we can create this smartphone based computing solutions that are privacy preserving, but make the invisible data visible.

Rashmi Mohan:
I mean, it's the absolute need of the hour. Ramesh, obviously, like you mentioned, this has been an absolutely terrible sequence of events that has happened impacted the entire world and anything that we can do to sort of ease the pain and sort of maybe at least stem this rapid spread of the infection would be tremendous and I think data is definitely the solution to that. But what I also find interesting is that in your journey in your career, there's been a lot of intersection of your computing work with healthcare. You've always been interested in it. How and why did that occur?

Ramesh Raskar:
Yeah, I think when it comes to kind of the fusion of the physical and the digital, people who think about the atoms in terms of visual computing, it's displays and cameras, and so on, they have this feeling that as long as they do really good devices, all the problems will be solved and you can kind of call them kind of photon chauvinists. And on the other hand, there are people on the computing axes who think as long as you do great machine learning and computer science and signal processing and build great processors and so on, we can solve any problem and let's

call them computational chauvinists. But I think the real action is at the intersection of the physical and the digital. And so it always fascinates me to think of that as a joint optimization, joint or co-design of the physical and the digital.

Ramesh Raskar:
So yes, a lot of my work thinks about how can we build medical devices that fuse clever sensing mechanisms with computational mechanisms. And that's the device you mentioned, EyeNetra, which has a device to get prescription for your eyeglasses by exploiting extremely high resolution displays on smartphones. Two as I mentioned, cameras that can see around corners. I mean, there are many teams that are working on lasers and many teams work in computer vision, but maybe our team was the first one to think about them in a joint manner. And the same thing here with COVID-19, which is many folks working in digital health and many folks working in privacy, computational privacy.

Ramesh Raskar:
But I think our team was able to bring them together and deploy them at scale as well. At the same time, there are many open research problems in this field of how are we going to create what I like to call participatory epidemiology, which is kind of cult source notion of public health. Not relying on what CDC is telling you or the CTR count is telling you, but the drugs coming from the users in real time, again, like Waze for public health.

Ramesh Raskar:
So there's something magical when you try to think about when you do co-design of the physical and digital systems.

Rashmi Mohan:
Yeah, absolutely. And the interesting thing that sort of comes through in your conversation is also how you've made this journey from being a researcher to sort of working in the practitioners world so seamlessly. I mean, I looked at your LinkedIn profile, it shows you as a co-founder for so many initiatives. How do you straddle both those worlds as being an entrepreneur, as well as sort of pushing forward on your research work?

Ramesh Raskar:
I believe in a very fortunate world where when I was a graduate student, the best thing you could do was write a paper, do your thesis and maybe somebody will pick it up. Maybe somebody will build something and maybe 10 years later there'll become a real product. I think the beauty for the students today and researchers today is that they can go from an idea to impact first of all

completely on their own, and also in matter of weeks or matter of months. And that's just a blessing for kind of computational researchers nowadays. I think the mistake a lot of us do is trying to stay siloed, which is just do research or just do entrepreneurship, or just do social impact. And I feel we can seamlessly move from them because to me there's all learning experiences.

Ramesh Raskar:
I'm the youngest of four. I've four siblings and I thought that the more I talk to my siblings, I learned so much. So I had this benefit of being the youngest. And I feel like as long as we moved around in this areas, we learn from them. And as long as we don't have preconceived notions of what these particular concepts should be. So I started the health innovation team at Facebook. I have done several startups, I've launched a few nonprofits, but what I like the most is doing research and being a professor. And this is really a unique world we live in and it really changes the way I think about research problems, that impact how disparate ideas connect with each other. Also getting stimulated by a lot of young talent that I meet in different contexts. So I think being a professor is the best job in the world. And by dabbling in kind of real world scenarios informs how to be a great researcher.

Rashmi Mohan:
Yeah. I think you hit upon an incredibly important point, which is really the ability to leverage this community that we're surrounded by Ramesh. I first heard you speak at the NASSCOM product conclave in India in 2014. And I know you were talking about solving problems at scale, and you were excited about your work at the 2015 combi Mila [phonetic 00:23:19] . And that's where I heard about your project REDX. I'd love to hear more about what were you thinking when you started that initiative and where is it today?

Ramesh Raskar:
Yeah.So REDX is an idea that it's peer to peer invention, especially focused on AI and data. And as you probably saw, when I was talking back five, six years ago, many talented folks in mid income or lower income countries have this artificial barrier will say," To do great work. I must go to MIT." And as much as I love being at MIT, I think nowadays the opportunities are everywhere and anybody with access to the internet can probably make amazing things happen, especially in the world of AI and data. The challenge seems to be that we continue to teach our students and even our researchers, the way we used to teach them 20 years ago or 30 years ago. And when I teach at MIT nowadays, I realized that the students actually are very, very well-versed they're watching videos, they're talking to each other.

Ramesh Raskar:
And for me to walk into a classroom and teach from a classic textbook has a very limited value nowadays because most of those videos are available online. And what really matters is hold do I stimulate the peer to peer kind of invention and exploration. And that's where we launched this REDX platform, Rethinking Engineering Design Execution, of how do we stimulate and how do we get the youth to think about the societal problems and apply computing research and computing ideas to those societally impactful, important problems.

Ramesh Raskar:
And I think that has really worked because I see the REDX, unfortunately when I received the Lemelson award, which is half a million dollars that just show up in my bank account I transferred all of that to start this foundation for REDX. And so we support lots of clubs all over the world, college clubs, there's a college clubs for AI for Impact. And it's an ongoing program. It doesn't scale as much as I would like to see, but it's ongoing in many parts of the world, but the main output from REDX is just the philosophy and the formula. So they, of course we have made it open source. So when I was at Facebook on my sabbatical leave, I launch two different labs based on the REDX principles. And we continue to do more work in that space.

Rashmi Mohan:
Yeah, it's incredible. I think fostering that kind of freedom to innovate and actually make an impact for societal good is something that I think as computer scientists, we have the power to be able to do that. And definitely seems like a worthwhile investment of our time and energy. One of the other things that I also heard a lot about while I was looking up, the work that you've done Ramesh is you speak about innovations, growing your career and strategies to innovate better. Do you believe that innovation is something that is a learned skill and can be honed?

Ramesh Raskar:
Definitely. Definitely. I think there is definitely in the beginning it feels like it's this chaotic process, but you know how to invent, how to innovate, how to work in teams and how to stay focused on your goal. All can be learned and taught (in fact) - I have a whole lecture, a whole document on that called Idea Hexagon. And when I came to MIT as a professor in 2007, 2008, I was working in industry for several years. And when I met my students in the first year, I realized, their expectation is that they'll spend a year or two just taking classes and maybe in the third year they will start doing research and start inventing new things. And that didn't make sense to me. And I said, "Why can't you just start on day one, thinking big and thinking about the crazy ideas and, and collectively we can guide you."

Ramesh Raskar:
And so I said, okay, I'm just going to put all my skills, everything that I have learned about how to invent and how to research into a manageable kind of bite-sized format and created something called an Idea Hexagon, which is, if you have an idea X, it tells you what could be next. And the basically six it's like an algebra on the idea. And by doing that, you can do that and have used that in many courses and many innovation workshops, I have done all over the world. So that's just the one example of having this training the muscle in your brain that's constantly thinking about it if you know, X, what is next.

Rashmi Mohan:
Got it. Yeah. I did see, I have seen the lecture about Idea Hexagon, and I think it's fascinating. Has that framework changed at all or altered in light of the fact that we have a new way of working now where you don't have the kind of bundling of ideas that happen either in a lab or in an office or in a classroom environment or a whiteboard to brainstorm, what do you think is going to change now that we're all sort of remote? What do we need to do to foster the collaboration?

Ramesh Raskar:
That's true. That's true, Rashmi. I mean, we live in a whole new world and there's so many theories of what could happen even after the pandemic is over, but I'm fascinated. I don't have great answers, but the fundamentals will not change. I think I like to tell my students that when they wake up in the morning, they should just follow five letters and I call them STAMP: space, time, action, money, and people. So you wake up in the morning and so do I need to deal with any of these five issues today? And research is all about STAMP: space, time and money and people. So if you can do that and the last one of that is P which is people I think, as we go forward we going to work on problems. If we think our pandemic is not just a biologic problem, it's not a technology problem. It's really a social problem. It's about people, right? And so I can see tremendous progress in computing that's people-centric and not necessarily centered on physical, chemical or purely computing principles.

Rashmi Mohan:
Absolutely. I think the biggest sort of problems we will have to solve are around how people are feeling, how do we work and interact with each other? How do we build social connections? I mean, I have daughters in high school and for them to be able to go through this entire experience of high school without meeting their friends or teachers in person has definitely been a challenge. And so I think innovation in those spaces will be welcome to parents like myself and certainly the younger generation of students that are going through this experience. You know

what Ramesh? I mean, on a more lighthearted sort of note what do you do outside of work? Like what are your interests or pet projects, hobbies? We'd love to know. I'm sure our listeners would love to hear more as well.

Ramesh Raskar:
I'm a pretty geeky guy when it comes to that, I like to pick up one skill at a time on my sabbatical leave. When I was at Facebook I said I'm going to pick up rock climbing and skateboarding. So I picked up a bit of that. And again, for me, anything that looks magical, something that seems impossible for humans to do, whether it's in terms of research or invention or just personal activities, is what really attracts. So I love magic tricks. I love to learn how to do magic tricks and show them to my family members. So you'll see me, even if I'm kind of on an airplane, I'm probably looking at YouTube videos of magic tricks and that's what really keeps me going.

Rashmi Mohan:
That's fascinating. We look forward to your next talk and the magic tricks that accompany it. So what is it that you're most excited about, or what do you think is magical in the field of computer vision over the next say five years?

Ramesh Raskar:
I would go back to say we have an ability to now create a God's eye view and again, not to get religious about it, but really kind of being omnipresent, omniscient. And if you have that ability, we can solve many problems in society, whether it's health, transportation, climate, or even democracy with that. And we can do that only if you can solve the problems of private preserving computation, privacy preserving machine learning, privacy preserving computer vision. So I think five years from now, we're going to look back and say, we had this untapped potential and we kept on hitting against the wall of siloed data. And that's what was preventing the solution machine intelligence to really scale and we have unblocked that with privacy preserving computation. So we think that this magical ability is to make the invisible visible, which is creating new computer vision on objects that you cannot even see and creating new computer vision on data that's siloed away is probably going to be something very important and then five or 10 years from now, it will be like the green padlock and the internet browser.

Ramesh Raskar:
I mean the mid nineties, if you were to type a credit card number in a browser you would do that with trepidation because you didn't really know what's going to happen to that your credit card number, because those of you who understood DCPIP protocols those packets are going in the clear. So anybody could tap and look at your credit card number. But of course, then we had

HTTPS that creates an encrypted channel between the browser and the server. And all of us look at the green padlock and say, "Hey, this is perfectly fine to use our credit card." And I think five or 10 years from now, we will look back and say, "Actually I don't really care about sharing everything about myself. My diabetic treatment or the treatment is going, what my social graph is. All the cameras in my house can look at everything that there is. I can send the data in an encrypted form to some service where the service, you cannot even see ever raw data get me results from it."

Ramesh Raskar:
So we will live in this kind of information rich world that has very, very low friction in terms of the data exchange. And that'll be kind of just a golden era that unleashes the value of computer vision in terms of physics or in terms of the physical or the digital aspect of computer vision to bring this great benefits in personal lives, but also in the society.

Rashmi Mohan:
I think that sounds liberating. It sounds empowering. And I'm really looking forward to the vision that you just painted. You know what I mean? This has been, without being facetious, an eye opening conversation. Thank you so much for taking the time to speak with us at *ACM ByteCast*.

Ramesh Raskar:
Thank you.

Rashmi Mohan:
ACM ByteCast is a production of the Association for Computing Machinery Practitioners Board. To learn more about ACM and its activities visit acm.org. For more information about this and other episodes, please visit our website at learning.acm.org/ByteCast. That's learning.acm.org/B-Y-T-E-C-A- S-T.