Announcer:

Hello and welcome to the Federal Highway Administration's or FHWA’s R&T Now Interchanges the host of today's audiocast is Craig Thor. Craig serves as the chief scientist in FHWA’s Office of Research, Development and Technology. Please welcome Craig Thor.

Craig Thor:

Joining me today is David Kuehn, the director of the research Innovation management team at the Federal Highway Administration. In this role, David leads the exploratory advanced research Program as well as a small business innovation research program, activities related to technology transfer as well as evaluation programs.

He also assures the communication of our research results from those programs and fosters partnerships with federal agencies, national scientific societies and organizations, and the academic community. David holds a master's degree from the University of Southern California and a bachelor's from the University of California at Irvine. It's a pleasure to have you here today, David.

David Kuehn:

Happy to be here and have our opportunity to talk about artificial intelligence and how it can benefit highway transportation.

CT:

Great. So I want to start out by focusing a little bit on the exploratory advanced research program specifically. And when I describe this program to others, I talk about how at the Federal Highway Administration, we don't do basic research or fundamental research, but this is the program where we get the closest to that type of research and where we look at what comes out of those types of programs and saying, what are the transportation applications?

And I think a prominent example of that is artificial intelligence and how we can use artificial intelligence for transportation. So knowing what you know about what's happening in other parts of the federal government, as well as research in general, what advancements in AI have you seen that you are most excited about for transportation?

DK:

Well, there are a few areas where we're really focusing right now, and one is to support vulnerable road users. So that's pedestrians, cyclists, other people who don't have the protection of vehicles when they're traveling. And so we're looking at systems that can identify situations in the roadway, look at what might happen in the near future. And then how do we use that to ensure or support safety, through control mechanisms, which could be, changing signal timing.

It could be providing messages to vehicles. Could even be giving warnings to pedestrians about oncoming cars. So, for instance, one project that we recently funded, was led by University of California, Los Angeles and University of Cincinnati. And what they were looking at is using artificial intelligence to combine information from different places. So some of that is from roadside sensors. Some of that was from sensors and vehicles. It included camera sensors. It also included lidar. And the idea was to be able to get a better understanding of the whole scene and being able to combine the signals from different sensors and be able to provide that information to everyone nearby allows for really what we call shared perception. And to be able to do that, you need artificial intelligence to be able to really understand in quick enough time what is going on in the scene and provide actually useful information to the people who are driving or walking or what have you.

CT:

So you talked a lot about how we're using sensors and cameras. They collect data of various types in order to help advance on a road user safety or other forms of safety in the transportation environment. Can you describe a little bit about how that actually works? How do we combine that data together? How do we turn that data into information that's useful through artificial intelligence, machine learning, these types of tools. What's the process that's used in order to make that actually useful to us in the real world?

DK:

So that's something that you can do with modalities in a lab. It's much harder to do in the real world. And part of the issue is that these sensors work in different ways. So they collect information at different rates. They're in slightly different locations. And so one of the things they have to do, and this is part of where artificial intelligence helps, is, for instance, we have another project, that is led by University of Tennessee, Chattanooga, and they're using artificial intelligence to identify objects in the scene through these different sensors, whether it's lidar, our radar or image, determine whether these are the same object and use that to help calibrate the location of what they're looking at.

And so that way, if they can find common objects, you can say, okay, you know, these signals coming from the lidar match these signals coming from the camera. And they're actually using this to help. For instance, look at where things are in, in the roadway and then project where they might be again, to try to identify where there might be conflicts, between vehicles or between vehicles and pedestrians.

CT:

So you mentioned that transitioning things from the lab to the real world can be a challenge. And that's true across research in general. It's not specific to this question, but I think it is particularly relevant here because of what you I've already described a little bit, which is about the complexity of the environment that we're working in. There's so many things that can be going on in the transportation environment, and how are we making sure that we're being complete in the the way that we're looking at the transportation issues? And I mean, as far as making sure that everybody is part of the conversation is being considered in our transportation, the research goals. And how important is that when we think about how we focus our research objectives.

DK:

So we need to take AI a step at a time. You need to make sure and assess how well it works in the lab with data that you know about, data that you've actually ground truth. So you know what the right answers are. From there, you might take it out to a controlled situation. So that might be at the laboratory here at, Turner Fairbank Highway Research Center at our instrumented intersection. It might be on a campus location. And again, you look at each component of the system. So is it correctly detecting objects?

Is it correctly projecting where those objects might be in the future? And you really want to be, assured and in tune and understand the level of performance before you actually connect it with the control systems that actually send some sort of signal that says, here's a warning, or here might be something that initiates braking in a vehicle or changes the signal timing. So a lot of times you might have these algorithms running in parallel in the background. So you're looking at sort of a artificial view of the world. This is what it would look like if the system were working. And then you have the actual view of the world, and you can start seeing where the system works and where it doesn't.

And these systems may not work all the time. There may be situations where, for instance, there's dense fog and some of the sensors don't work well, or there might be other sorts of issues where if you know when they work and when they don't work, you can be assured, like, we'll make sure the system's working when it's an environment where it can work and we're not going to tell people can work in environments where it can't work.

CT:

That's great. Thank you. David, I want to move beyond just the exploratory advanced research program and to some of the other areas that you also support in your portfolio with your team, and specifically the Small Business Innovation Research Program, which focuses on commercialization of transportation technologies to support our transportation goals, and also the research Associate program, which is a way that we can bring on expertise through post-docs and other academics to come work with us to supplement our expertise at Turner Fairbank and in the research program. So within those programs specifically, how are we looking at artificial intelligence and leveraging those capabilities?

DK:

In the Small Business Innovation Research program we were looking for mechanisms to improve, again, traffic safety for pedestrians, mechanisms that would work in areas that had less infrastructure. So this might be rural roads or even suburban roads, where you might not have signalized intersections and everything that comes with that, because signalized intersections, you have power, you often have cameras, loop detectors, a number of things that really are able to provide you information about what's going on in terms of, the vehicles and pedestrians in the area. So this project really took, the idea of using artificial intelligence and computer vision, created a small package that was low powered, instead of using very large algorithms that you have to do either in the cloud, on large servers of computers or on some multi-core computer, you're able to actually do that on an edge device and say, okay, what can you do with a simpler algorithm?

And if you can do it cost effectively, really is a great, project. So that's one of the projects that we're funding under SBIR. In terms of the research associates, we have a couple of research associates in different areas who, again, are using really advanced algorithms. And so for example, looking at condition of, of materials. So if you have, for instance, cement beams, they might have surface cracking or there might be also issues, with the steel reinforcement, in terms of corrosion. And so it's sort of like medical imaging. You can have a lot of radiologists that will look at the image, and they may not all agree on what they're seeing.

So one of the difficulties with this really great signal technology using different types of things like ground penetrating radar, like, acoustical emissions, is that the signals are very difficult to read. And so having AI look at and train on a lot of signals where you actually know what the conditions are, and if you could put these sensors out there and have a machine reliably read and understand and interpret the signals, you could more effectively say, what are the conditions, both visible and not visible, and use that to better provide an estimate of what's the continued service life and reliability of of that part of a structure or part of a roadway.

CT:

So you mentioned in there both the cost of this technology is going down, as well as new approaches, things like edge computing, which allow us to deploy these things in the field in low power, low cost. And it's providing more access to some of these technologies as well as things like machine interpretation, which you just talked about, which allows us to understand the data more effectively, and particularly for those who may be working in the field or working with the technology more directly and aren't working in a lab. So it's making the information more accessible to transportation professionals. So with all of that, it sounds like we're going to be seeing eye touching a lot of different things in the transportation environment, in a lot of different ways. What about these deployments do you see are going to be most transformational for the highway system into the future?

DK:

So one area that I think is going to be really huge for transportation agencies is both a level of automation and, a level of management, both in construction and maintenance that doesn't exist today. Construction is a difficult and dangerous job. Being out of work zone is tough. It's loud. There's traffic rushing by. You're using heavy equipment to the extent that you could have the same people who are operating those equipment in the work zone be able to operate and manage and oversee the equipment from a construction office, I think they would be much safer and have, you know, really use what humans do well, and that is using their mind to understand what are the critical and salient issues as part of that construction and let the machines do what they do well, which is manage the repetitive tasks, the heavy tasks. So that's one area where I could see some real benefit.

CT:

Thanks, David. I think that example you just gave around construction, and work zone environments is, is really a great example of how we can use AI to advance safety outside of the vehicle and outside of pedestrians, vulnerable road users. But the people who work in the transportation environment on a daily basis. And we think about safety, it's important that we be able to trust these systems, these AI systems and that humans still be part of the decision-making process. Can you provide a little bit more perspective on how important do you think that is, and how that's going to work in the future as we continue to adopt more of these technologies?

DK:

Certainly having human oversight, human control, coordination between machines and people is going to be very important for the safety of a lot of systems. So, for instance, if the machine is looking at large amounts of data, more than an individual could easily look at, and using that to provide suggestions on, for instance, winter maintenance approaches, which is another project that we funded, then that human can use their judgment and say, this is a good suggestion or this is not a good suggestion.

And it could also allow the system to learn based on the feedback from the human. So together they get better. There are some instances where there's going to be limitations for where people can provide oversight, and a lot of that is in quick decisions. So if you have, for instance, an automated braking system or you have a signal system that's going to, let's say, hold the yellow phase because it's anticipating that someone needs more time to cross the roadway, you're not necessarily going to have time for a human to sit and review that decision.

On the other hand, you can still have humans look at how those systems are performing and look retrospectively and saying, is the system performing the way we intended it to? Is it performing within our expectations? Is it performing in a safe way? And having that monitoring function, which is still done by a person, really will allow to say, okay, this system is no longer performing in the way we expect it to. We may be need to retrain it or take it offline. And I think that's going to be important element that human control is going to take place at some point. But the human may not always be directly in the loop of the decision.

CT:

Great. Thank you, David, and thank you for joining us today. I think this conversation highlights how artificial intelligence is not going to replace humans in the transportation environment and the decision-making process, but it's definitely going to augment our ability to both be safer in that environment, to have the or the transportation environment operate more efficiently. To look at things like sustainability of the infrastructure itself. It's going to be an important tool for us as we move forward. And I think the exploratory advanced research program, the SBIR program, as well as the Research Associate program are going to be great ways to supplement the work that we do and conduct the research that is going to lead us to the transportation system of the future. So thank you for joining us today.

DK:

Oh, thank you. It's a very exciting time to be working in research.

Announcer:

Thanks and will be back soon. Want to see a topic covered in a future episode? Please send an email to FHWA-NOW@dot.gov. To download new episodes of our conversations, go to our R&T Now Interchanges web page.

Take care everyone! Until next time.