Announcer:

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

Craig Thor:

Thanks. I'm looking forward to a conversation today about the use of artificial intelligence, and specifically how we use it to ensure that the infrastructure is in a state of good repair. This involves using lots of data, using AI tools, and investigating problems that maybe the human eyes can't even see. Joining us today is someone who knows a lot about the applications of artificial intelligence to ensure the state of good repair of our infrastructure. Dr. Hoda Azari. Dr. Hoda Azari is using artificial intelligence in a number of different projects, specifically within the Nondestructive Evaluation Program, where she serves as the research program and laboratory manager. Structural engineer by training, her expertise is in nondestructive evaluation or NDE and structural monitoring, or SM of transportation infrastructure. Hoda has 20 years of experience in transportation research. She holds a PhD in infrastructure engineering from the University of Texas at El Paso. It's a pleasure to have the opportunity to talk to you today, Hoda.

Hoda Azari:

Thank you Craig. Thanks for the opportunity, and I'm glad to be here today.

CT:

So as the program manager for the Nondestructive Evaluation Program, I think my first question will be a pretty easy one. What is NDE and why is it important?

HA:

Sure. So, just like doctors that use diagnostic tools like MRI, CT scan, ultrasound to get a better understanding of the patient's condition without any invasive procedure. Nondestructive evaluation or NDE technologies is used to assess the condition of highway infrastructure assets like bridges and pavements and tunnels.

So, these technologies can be used to identify defects in bridges and pavements and tunnels that might not be visible to naked eyes. They help asset owners make informed decisions and plan preservation activities more effectively.

CT:

Great. Thank you. I think that'll help our audience understand what we're talking about when we talk about nondestructive evaluation. Can you explain a little bit about how AI is a useful tool in nondestructive evaluation, and how it's enhancing our ability to understand the information that we receive from these tools?

HA:

Absolutely. We've been working on a few projects over the last few years, and the results are very promising. One of the studies that we're working on for a while is to use AI to analyze NDE data to detect defects in bridge decks. Then we took one step further, and used AI to fuze multiple NDE data from various technologies and predict the future condition of the bridge.

Like for example, to predict growth rate of cracks and delamination and corrosion based on the patterns that are observed from previous scans from historical data. So this predictive capability helps asset owners with anticipating future needs, which potentially saves cost and prevent failures. Another study explores how AI can learn from one type of defect map to generate other types of defect maps. For example, developing a delamination map based on corrosion data.

And this is a step forward in making preservation planning more efficient and data driven.

CT:

Can you describe how asset investigations are done currently? Before we get into how AI is going to evolve them?

HA:

Sure. So, the current practice for testing highway infrastructure is visual inspection and also chain dragging, where the inspector drags a chain on the surface of the deck to hear the sound. And based on the sound, they make a decision on the condition of the deck, for example. And as you can tell, it's a very labor intensive and subjective process. And what NDE is trying to do is to provide data to asset owners to make informed decisions about the condition of the assets.

CT:

Great. That's excellent. So, I think what I'm hearing also, though, is that there's still going to be humans out in the field using these tools. Right? In that, the AI is there to enhance their ability to understand the information, to understand the structural health of the infrastructure. Can you explain how we can use AI to augment human abilities? We're not replacing the human, but we are enhancing what the human is able to understand and how they're able to predict.

HA:

Sure, yes. So when we talk about human error and infrastructure assessment, we are referring to inconsistencies and inaccuracies during data collection and data interpretation. If you give two engineers the same set of data to analyze and to process, they come up with different results, which leads to inconsistent conclusion about the condition of bridges or pavements. What AI can offer is an objective approach. AI can detect patterns and damage indicators by analyzing large NDE data sets.

But I have to make a point that AI is here to help humans, and it's not here to replace humans. There is always a need to check the accuracy of the results by a human.

CT:

Great. And I think one of the aspects about AI is the ability to, as you mentioned, digest the large amounts of data. And when you talk about NDE technologies, you're talking about many different types of sensors that are collecting lots of different types of information, lots of different types of data.

Can you talk a little bit about how we're using AI to deal with that large amount of data, and how to use the data from those disparate sources in a way that's useful to us?

HA:

So modern infrastructure projects use advanced tools like sensors, drones, NDE technologies to collect data on highway infrastructure assets. These data are great. They provide valuable insight about the condition of infrastructure.

But analyzing this data, it's a difficult task for traditional analysis methods. This is where AI can step in. It can process a vast data set quickly and efficiently. AI can identify patterns and trends in the data that humans may miss. Or they may not detect at all. So, for example, AI can analyze sensor data from bridges to pinpoint areas that need more attention, and to predict how these risks might evolve over time.

It can also combine data from different sources to provide comprehensive understanding of the condition of the assets. And a great thing about AI is that it continuously improves in accuracy as it learns from historical data, which makes it an increasingly reliable tool over time.

CT:

Great. Yeah. So I think a couple of things you mentioned in that answer, that I think are interesting is about how we can use the information to understand patterns and trends in maybe how the pavement or the bridge is deteriorating.

And that lets us understand where the potential problems are going to be in the future. Right? And so we know where we can focus our efforts. We know where these issues are going to evolve over time, as you said. So how is that information then useful to the practitioners in the field so that they can then plan ahead for what they see as potential issues down the road, that maybe aren't there now in the infrastructure, but they see could potentially be in the future?

HA:

Yes. So the asset owners can use this information for preservation planning. Preservation planning involves predicting when and where a repair and rehabilitation is needed to extend the life of infrastructure. And AI is a great tool to analyze a large amount of data that is needed for this planning process and can make this process more proactive, efficient, and data driven.

So, for example, AI can integrate and process historical inspection data, real time sensor data, NDE data, and environmental data, and can identify patterns and trends that indicate early signs of deterioration and can create predictive models to forecast when a bridge is likely to require repair and rehabilitation. And this allows asset managers to plan preservation activities well in advance, which avoids costly emergency repairs and minimize disruptions.

It ensures that limited preservation budgets are used where they are needed most.

CT:

And so, speaking of practitioners and the people who actually work out in the infrastructure, I know you're also involved in a study, a pooled fund study looking at human centered steel bridge inspection enabled by augmented reality in artificial intelligence. So the Pooled Fund program is a program, we work directly with the states. And in this case, it's led by a state. And I know that this project is showing how we can actually use this in the field and how it can truly augment the work that's being done by the practitioners. So can you expand a little bit on that project and what it hopes to accomplish?

HA:

Sure. So this pooled fund aims at automating bridge inspection process with a tool that incorporates computer vision, AI, augmented reality, and drones. So on the ground and the bridge inspectors will first take images and videos of the areas that they're inspecting with their headsets, or with the UAS flying around the bridge structure, and then the images and videos will be uploaded to the server and will be analyzed by computer vision and an AI algorithm to automatically create a defect map. Then these defect maps will be projected into the same area using the inspectors augmented reality headsets. So the technology is very promising. It will enable inspectors to perform bridge inspection more efficiently, which costs time and money.

CT:

From our discussion today, it's obvious that NDE has the opportunity to really change the way we consider the structural health of our assets.

 It's going to give us more information, and artificial intelligence is going to take it to another level. So we'll have much better decision making processes, make better decisions about where we need to invest our resources, those types of things. What are you most excited about, as far as the future of NDE and the use of AI, and where that's going to take us in this space?

HA:

Well, I envision that AI powered system can predict infrastructure failures well in advance, which allows asset managers to shift from reactive, costly repairs to proactive, cost effective preservation strategies. Also, the integration of AI with technologies like NDE, drones, digital twins, will change the way the asset owners monitor and manage their assets. Imagine a drone equipped with NDE and sensor technologies, collected data, AI process the data in real time, and the Digital twin updates the model in real time to reflect the current state of the infrastructure.

CT:

That's a great answer, Hoda. I think it shows how we're moving from the current standard to where we can go in the future, and how we're applying technology to really enable us to make better decisions, more informed decisions, and protect our infrastructure.

So, with that, I just want to say thank you for joining us today, Hoda. I really enjoyed this conversation, and I look forward to seeing how we can continue to apply AI in the future to NDE technologies.

HA: Thanks, Craig. Thanks for having me.

Announcer: Thanks. And we'll be back soon. Want to see a topic covered in a future episode?

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