Toyota’s Collaborative Safety Research Center Is Turning Corners To Help Improve Intersection Safety

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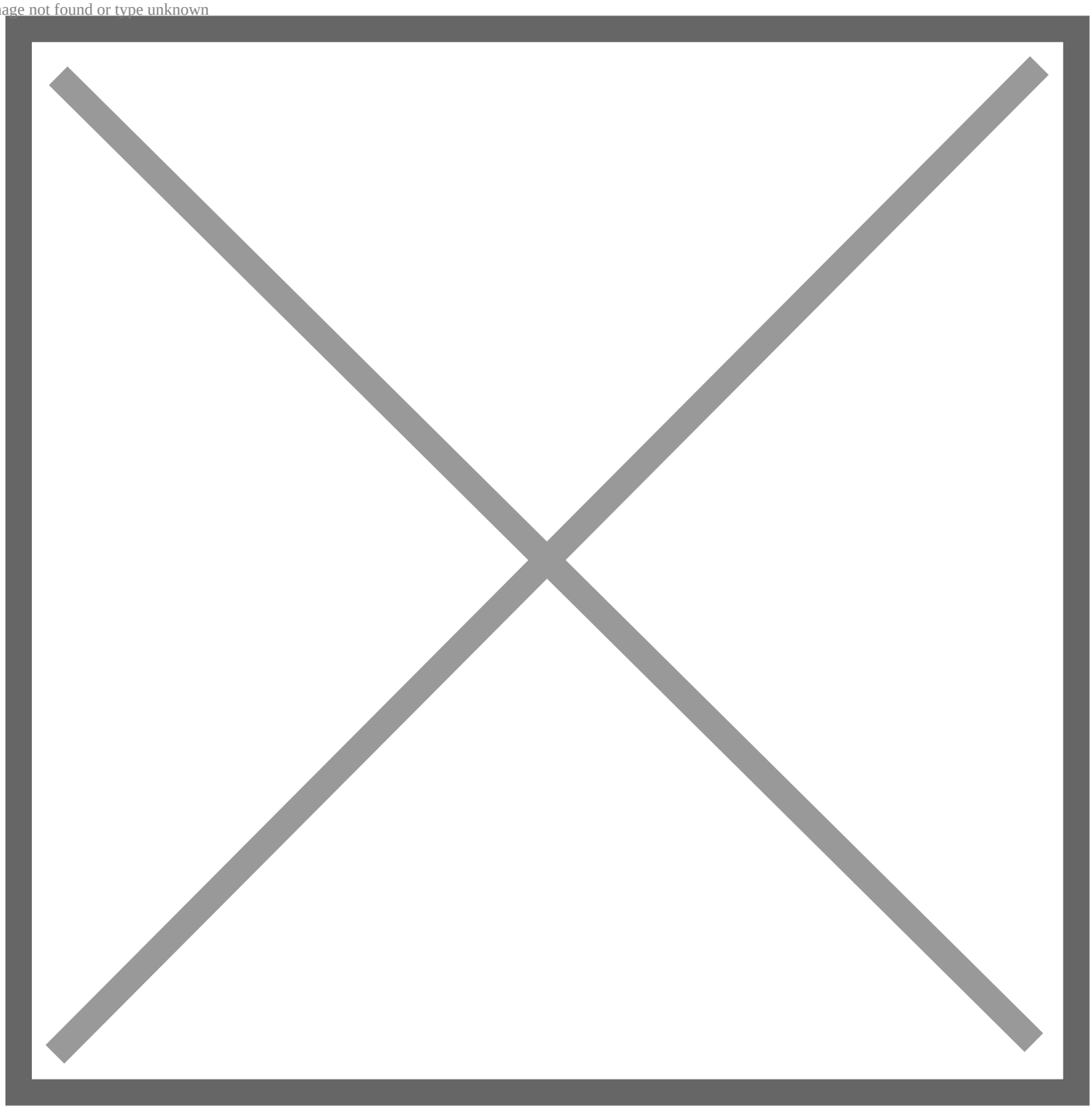
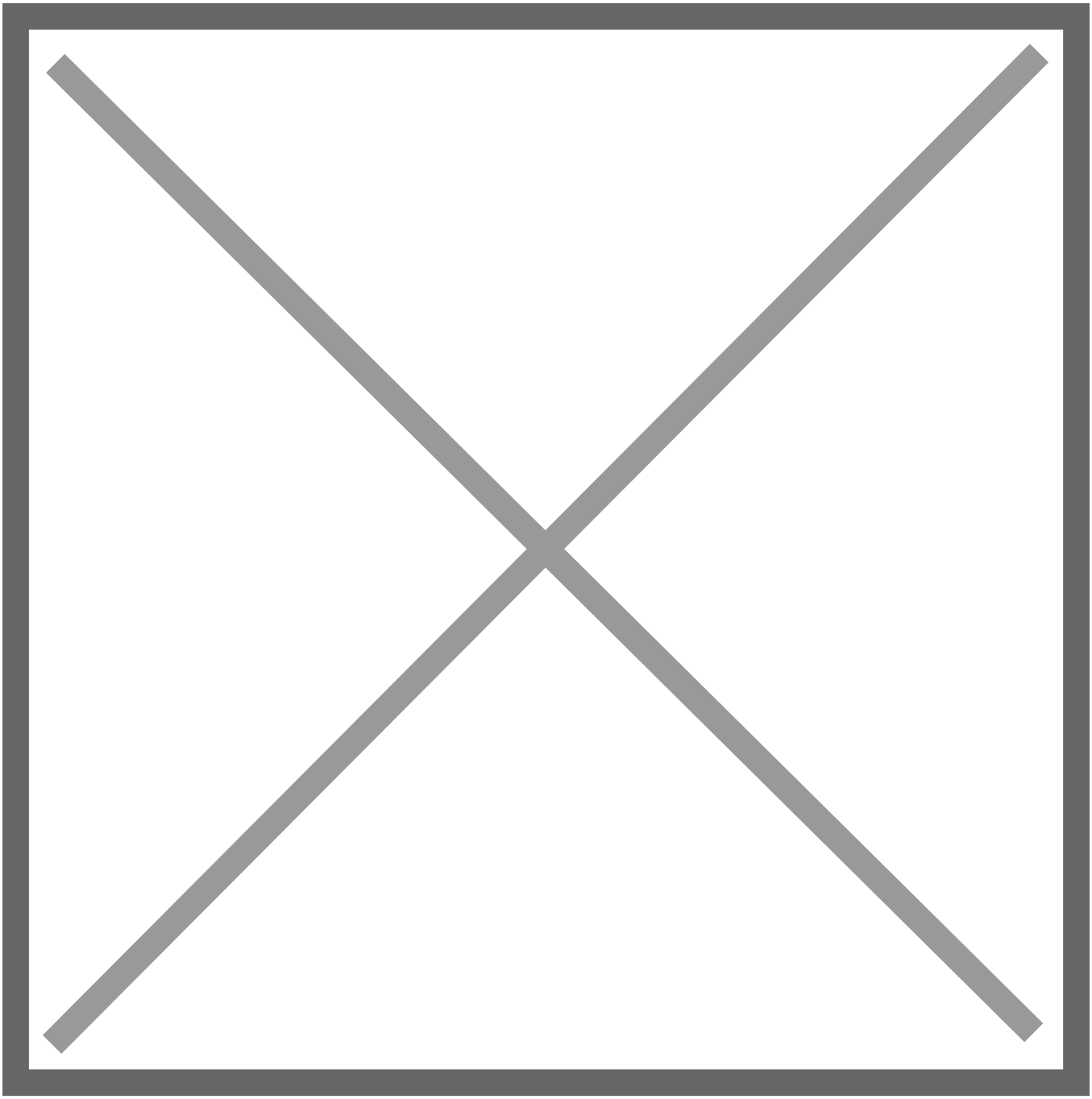


Safety is one of Toyota's top priorities. With more than 50% of the combined total of fatal and injury crashes occurring at or near intersections, the company works diligently to help prevent these outcomes.

Rini Sherony, who recently retired from Toyota Motor North America (TMNA) as a senior principal engineer at the Collaborative Safety Research Center (CSRC), says she enjoyed developing solutions that would help prevent crashes and potentially save lives.

She believes the Toyota projects that she worked on over the years were important and made a positive difference.

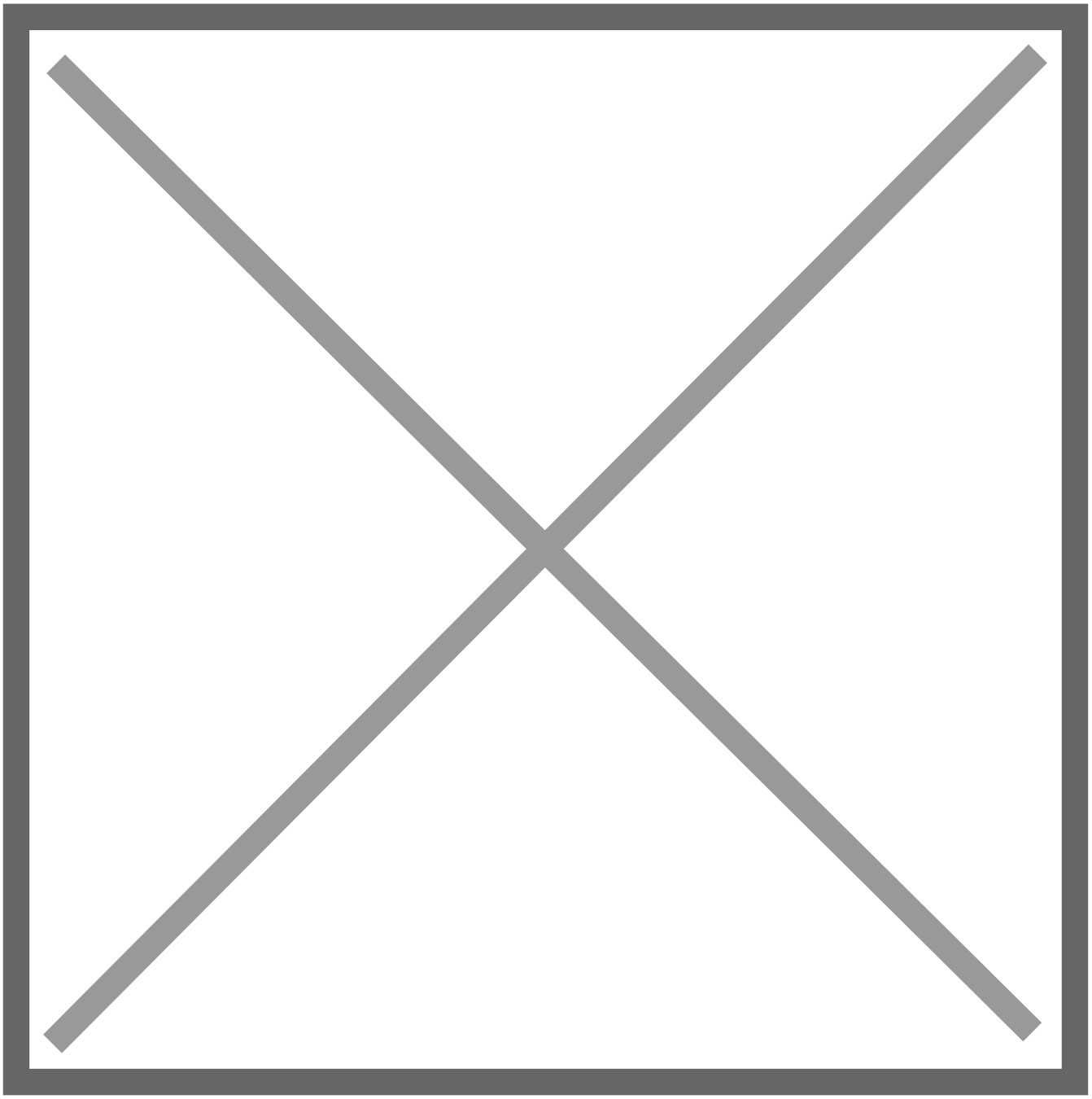


Turning a Corner to Better Safety

Sherony's last contribution at CSRC was the Intersection Crashes and Evasive Actions project. Over the course of three years, she spearheaded the project, along with Zhaonan Sun, a principal scientist with CSRC.

The team worked in collaboration with Virginia Tech to construct a driver behavior model in intersection crashes based on real-world intersection traversals. This model was applied with a potential Intersection-ADAS (Advanced Driver Assistance System) to identify potential unintended outcomes.

The study included three scenarios: Straight Crossing Path (SCP), Left Turn Across Path Opposite Direction (LTAP/OD), and Left Turn Across Path Lateral Direction (LTAP/LD). Evaluating these directions was crucial considering that intersection crashes are the second-highest number of crash fatalities and are the highest overall type of crashes in the U.S.



For several years, CSRC has been looking at different types of crashes and analyzing them.

“It’s so important to understand how the crashes happen on real roads, because you can develop effective countermeasures only when you know what’s happening on the real road,” says Sun.

These countermeasures, such as Pre-Collision System with Pedestrian Detection Lane Departure Alert, and more are featured in Toyota and Lexus Safety Systems. There are also crash avoidance tests and studies for different types of crashes. “We don’t just do one system and then we’re done,” he says. “Toyota’s philosophy carries continuous improvement.”

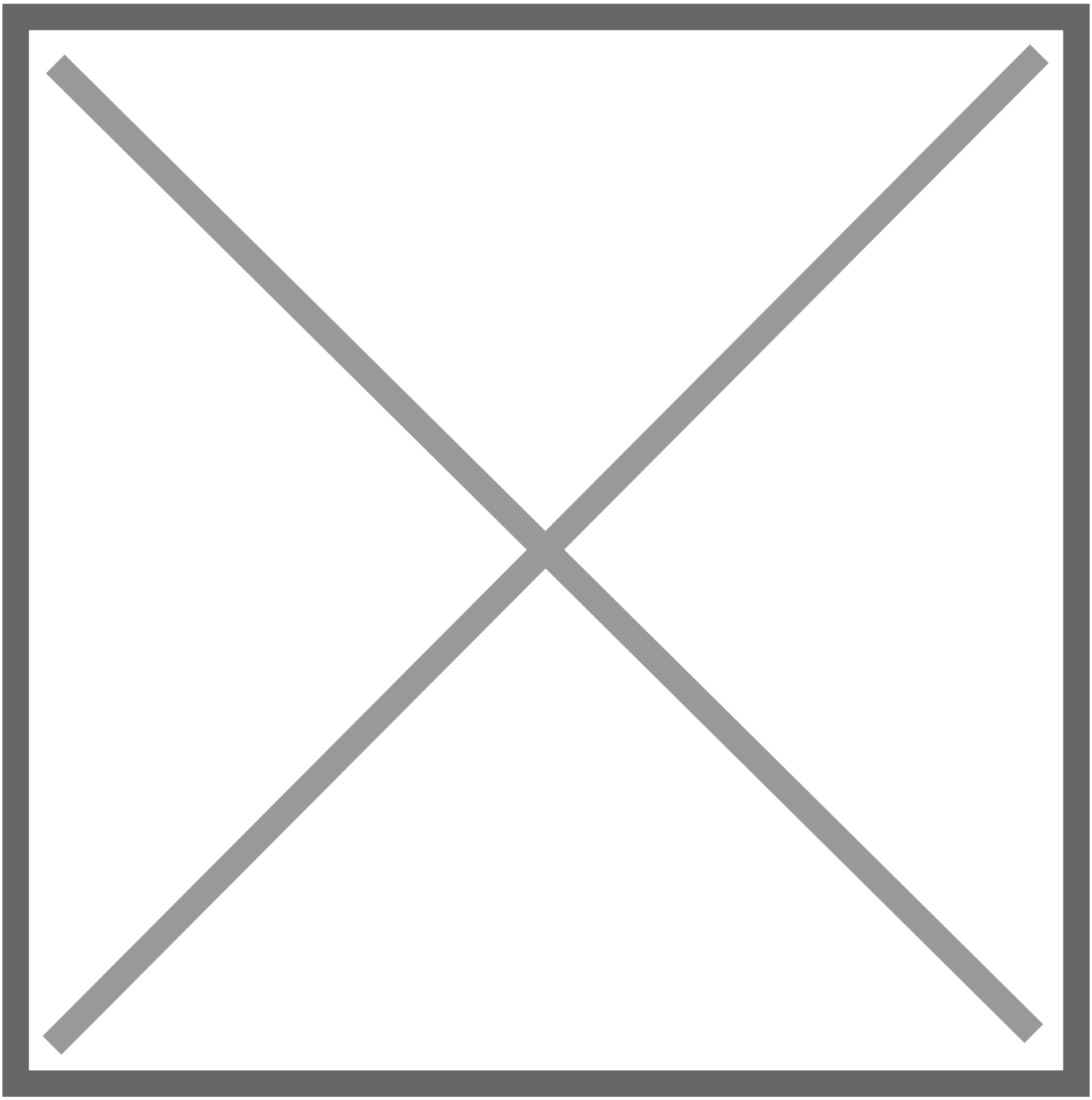
So, this project was designed to inform updates to Toyota Safety Sense (TSS).

“In the first version we looked at car crashes in depth and, how it happens from that we developed the countermeasure,” says Sun. “For the next version of the system, the team wanted to figure out how to integrate driver behavior like braking and warning so that it’s even more like what real-world drivers experience on the road.”

“So, we needed to look at naturalistic data from different sources, a representation of the real roads across the nation so we could create a reasonable model,” he added.

For this research, CSRC decided to partner with Virginia Tech again since they were instrumental in developing the first version in phase one (a driver behavior model in intersection crashes based on real-world intersection traversals).

“They knew what analysis is needed for system development,” says Sun. “So, they already have the knowledge, and the skill set, which was beneficial in developing the driver model and integrating it into the system updates.”



Data Behind the Development

With the new driver model as a focus, several driver behavior prediction models were developed from 43,000 crashes, near crashes and normal intersection traversal data in Strategic Highway Research Program (SHRP-2) and Virginia Tech Cameras for Advancing Safety Technologies (VT-CAST) driving datasets.

“We have the detailed scenarios, we know where the cars are coming from, we know what other objects are around, and we also know where the system is supposed to activate and at what speed. TTC (we call it TTC: time to collision),” says Sun. “So, we did all that and had the driver just sit there and do nothing in the simulation and then record if there was a crash prevention. The output is automatically generated and

aggregated. All these results feed into the machine learning algorithm, which is then added to the crash avoidance driver behavior model."

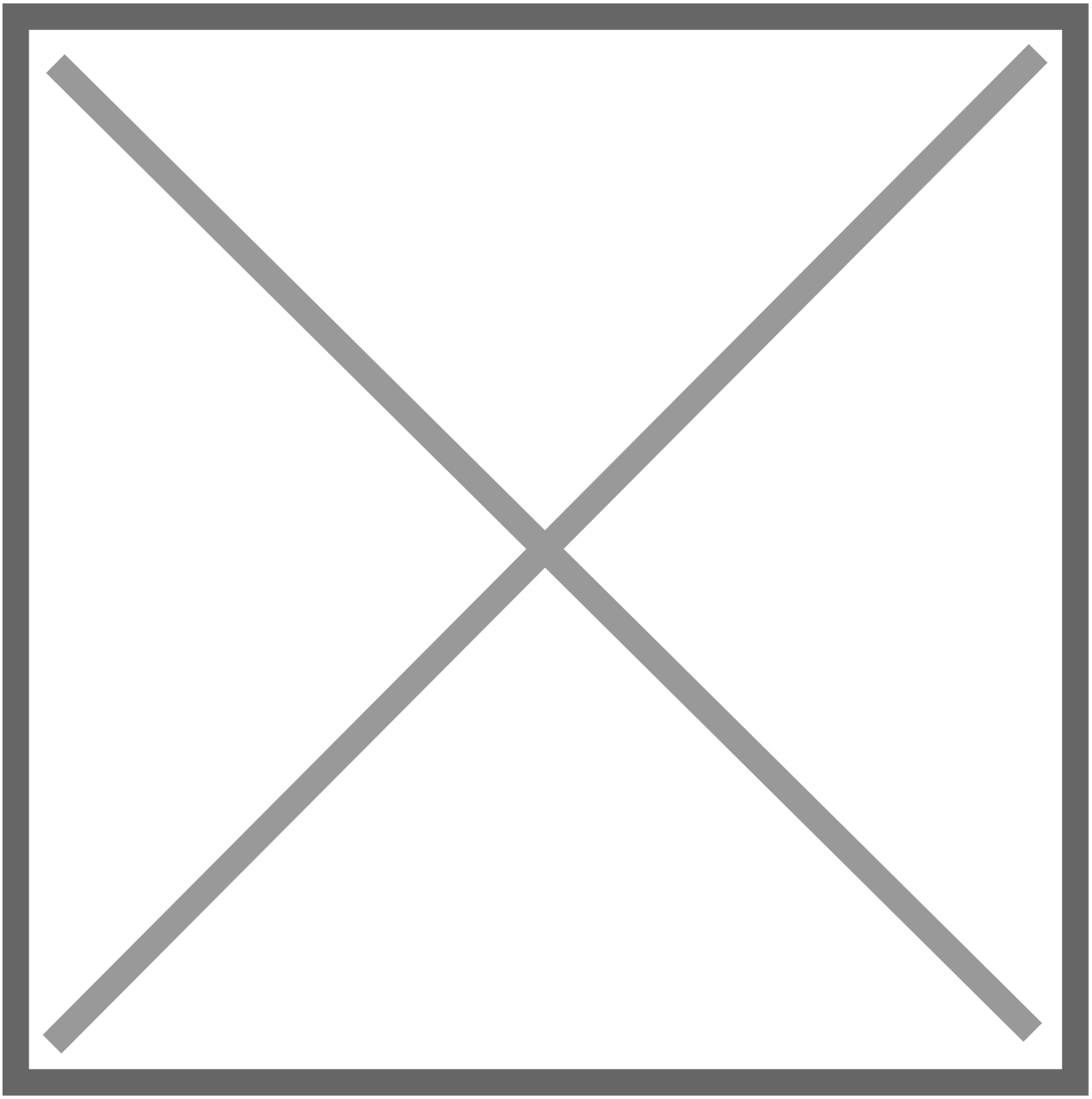
The models were used with I-ADAS system parameters to estimate crash avoidance in 2021 National Highway Traffic Safety Administration (NHTSA) proposed test scenarios. When I-ADAS was simulated without driver intervention, I-ADAS was activated in 93% of the crashes (48% crashes avoided or 45% of crashes were mitigated). I-ADAS with driver intervention (driver braking/steering) was only able to avoid 82% of the crashes.

Sun says they input thousands of different driver behaviors (attentive and ambivalent driver behavior) into each of the simulations.

"In order to estimate the benefit of it, you need to put everybody in there, right? You can't just use one person, and you cannot use one scenario, because then the results are going to be very skewed towards that," he says. "So, we threw all the driver models in there and ran all the simulations, and based on what was the output, each output was added together automatically, and that generated those numbers."

Also, these projects aren't simply done on a whim. They're intentional.

"We don't develop the systems out of the sky," Sun says. "We work incredibly hard and follow a very, very detailed engineering process to be able to come up with some of the system designs."



Surprises Along the Way

While some things can be predicted on projects like these, sometimes there are surprises along the way. Although the researchers knew that they were going to include the driver model component to the system, they didn't know that they'd see a lot of significant safety benefit from it, Sherony said.

"It turns out that when people are alert and they are paying attention, they can help avoid more crashes," Sherony says. "So, when drivers do take action and then you supplement with the automatic emergency braking, we get significantly more crash avoidance than with just the crash avoidance system. That was a very, very interesting finding, and surprising, that we did not think would happen."

Driving Home a Legacy
The retired Toyota veteran hopes that her latest project and all the others she's worked on over the years leave a lasting impact.

"I feel like I devoted my life to improving car safety," Sherony shared during her last days at Toyota. "I've been working on crash avoidance from when I started at Toyota and worked on so many different things and have the privilege of implementing many things. So, I'm retiring, but I feel like I'm kind of leaving my legacy behind in all these cars."

"When you don't hit a pedestrian then you are helping the pedestrian. When you don't hit another car, you're helping the other car occupants, too. The more crashes we prevent, it helps you. We are helping save people's lives. So, safety is extremely important." she added.