Small Business Innovation Research

SBIR SuccessSTORY

The Dilemma Zone

June 2022

Source: FHWA

Figure 1. Photograph. Intelligent transportation system at intersecting roadways.

It is a familiar situation that likely all drivers have experienced. To the driver, it is that anxious feeling, a quick decision to make in higher speed traffic. To U.S. Department of Transportation (DOT) researchers and engineers, it has a technical term: **the dilemma zone (DZ).**

Funding Research To Create New Opportunities

The DZ phenomenon is described as the moment when drivers face a predicament as a stoplight suddenly turns yellow, requiring either an abrupt stop or a rapid acceleration through the intersection. This situation is dangerous because a vehicle may have neither adequate braking distance to safely stop nor sufficient time to safely proceed through the intersection before the light turns red. As such, this aptly named scenario has caused high-speed rear-end and side-impact crashes at lighted intersections. However, in the last 5 yr, an SBIR-funded technology has helped make progress through a combination of technologies to alert drivers in advance of being caught in a DZ.

Intelligent Automation, Inc. (IAI) won both phase I and II SBIR awards (2014–2017) to find solutions to the DZ problem. The project's goal was to create, develop, and implement a multitechnological approach to warn drivers of the DZ, by integrating both infrastructure and onboard warning systems.

A few important technologies used in these systems included artificial intelligence (AI); dedicated short-range communications (DSRC), which is a short-range wireless communications system specifically designed to connect vehicles to each other and to the infrastructure; and a detection, control, and warning system (DCWS) that uses collected data to determine travel time (versus more conventional methods that use fixed areas). Furthermore, IAI had an existing technology it developed that focused on increasing dilemma zone safety using Intelligent Transportation

Systems (ITS). This system accurately identifies vehicles in the DZ based on the time it would take each vehicle to stop once a yellow light appears. Using sensors, the system identifies each vehicle's size, speed, and location to estimate the time needed to reach the intersection. When the two-part system determines that a vehicle will be trapped in the DZ at the onset of a yellow light, it uses advanced signal control protocols to adjust light phases and prevent DZ situations.

Infusion To Bring New Intelligence Capabilities

Because of the integrated warning system, when drivers are approaching or encountering the DZ, roadside flashers are activated, alerting them to slow down and stop safely. Ultimately, when the AI detects a car or truck (which have different braking distances), the AI will check its database for the vehicle type and its weight and length. Then, the AI determines the braking distance of the vehicle. In addition, the AI will factor in what the weather conditions have been to help calculate braking distance. (For example, if it has recently rained, the wet pavement will affect braking distance times as the moisture reduces the friction and traction. The tires will have less grip, which then requires a greater braking distance.) Based on all these collective data, the AI will then send a signal to the sensors at precisely the right time to activate the flashers at the signal light.

Source: FHWA.

Figure 2. Photograph. Intersection of four two-lane roadways.

Promising Results in Early Stages of Development

IAI worked with the Delaware Department of Transportation (DelDOT) to test this technology at two strategically selected intersections. Over 3 yr (2015–2018), the IAI team collected data and observed some informal patterns. Dr. Peter Huang, the contracting officer for this SBIR, said that the technology is showing promising results and likely improving safety at these intersections. However, he said that it is important to note that "there are not any real percentages to point to yet because it takes a few more years to gather and analyze data. It normally takes about 5 yr of data before *and* after the technology has been implemented to determine any patterns or decreases in crashes."

At the completion of the SBIR phase II, IAI wanted to continue to work with Federal Highway Administration (FHWA) and DelDOT to implement this technology at 10 additional intersections. In addition, IAI planned to make improvements to its DCWS system to make it more advanced. By doing so, IAI

committed to integrating the DCWS technology with signal controllers already on the market to make DZ protection become a basic safety feature for traffic signal-controlled intersections.

Another key success of this technology is that DelDOT decided to use State funds to continue improving the technology and to implement it in those 10 intersections. The willingness of DelDOT to keep investing its own funds, to continue the tests and research activities, and to upgrade the systems shows that there is real promise to this approach and that IAI's innovations are opening new doors for intersection safety that will only grow as the adoption of its technology becomes more widespread. Since the significant findings of the improved AI technology, DelDOT is planning to continue to make improvements and to deploy the technology even further: In 2019 DelDOT received a $5 million grant through FHWA's Advanced Transportation and Congestion Management Technologies Deployment Program, to which DelDOT is adding $5 million of its own funding, for a total investment of $10 million.

Furthermore, this technology has significant value because it will support connected and automated vehicles (CAVs) in the future. Currently, CAVs do not have this technology and will need it to safely communicate to drivers in the vehicle. However, in the future, this technology can be easily integrated into automated cars with DSRC wireless communications. When asked how to make other State DOTs aware of this game-changing technology, Huang said that it can be a challenge but external reports, publications, and conferences are vital to ensuring State DOTs remain aware of these innovations. However, Dr. Huang continues to highlight the promise these innovations offer by presenting at the Transportation Research Board annual meeting in recent years and by authoring several articles about this technology that have been published online and in technical journals.

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>
> *—Dr. Peter Huang*

State Funding Fosters Future Innovation

In the future, these systems can be integrated into the vehicle-to-infrastructure communication environment that the Federal Government is developing in coordination with State DOTs, private industry, and international partners. This DZ system should have significant advantage in making use of CAV infrastructure and technology as the research and use of connected vehicles continues. In the meantime, "…DelDOT plans to deploy these AI technologies, as well as other promising solutions, across the State in an effort to create a truly innovative, next-generation approach to traffic management that uses smart sensors and AI to provide the most efficient and safe operations of our highway network," said Dr. Huang.

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Digital Object Identifier (DOI):
https://doi.org/10.21949/1521913

HRTM-10/06-22(WEB)E
FHWA-HRT-22-084