

Innovative Headlights, Studied by CSRC, Could Help Save Pedestrians, Bicyclists

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The first half of 2021 showed a sharp spike in traffic fatalities – the largest in the 46 years since the National Highway Traffic Safety Administration (NHTSA) has been tracking the data. Pedestrian deaths are particularly high: more than 6,000 per year, up 46% over the past decade. Bicycle deaths are also on the rise.

Toyota's Collaborative Safety Research Center (CSRC) is part of a community of safety researchers and regulators working to understand the factors for pedestrian and bicyclist crashes. Recently, CSRC has been studying new ways to communicate between vehicles and pedestrians, using adaptive headlights, to reverse this troubling safety trend.

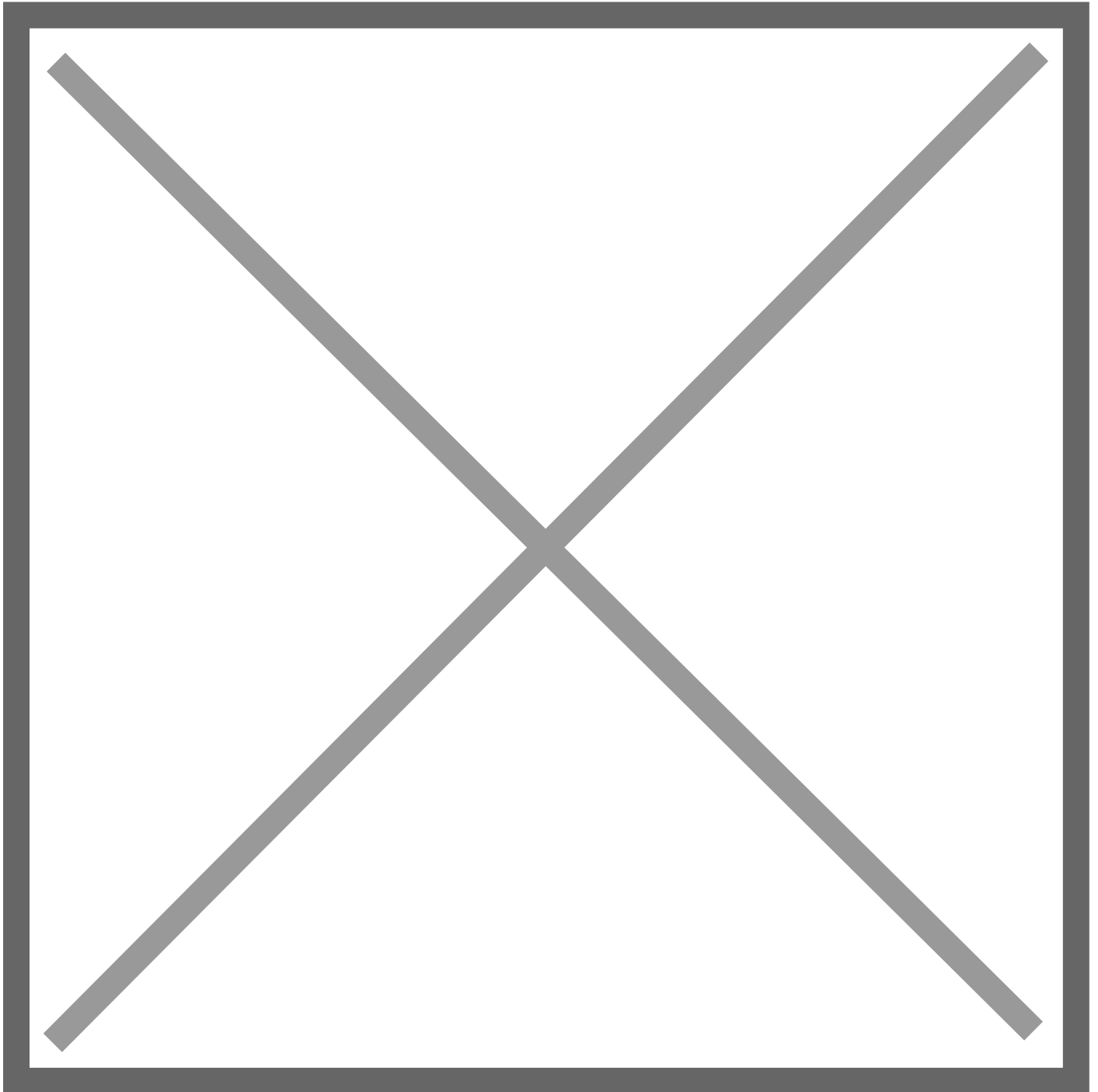
Adaptive headlights are a promising high-tech feature that combines multiple LEDs and computer chips. This can allow vehicles to project multiple points and colors of light in addition to the wide beam that illuminates the road for the driver. Toyota's CSRC researchers and its partners at the University of Iowa studied how these adaptive headlight systems could potentially draw attention to vulnerable road users and even communicate with them to help reduce collisions.



“A lot of times the pedestrian or bicyclist doesn’t know a car is coming up behind them,” said Rini Sherony, senior principal engineer at CSRC in Ann Arbor, Michigan. “If both sides know what exactly is happening, it can help improve safety.”

The headlight technology helps at night, when more than three quarters of pedestrian deaths occur. Previous research has shown that pedestrians generally overestimate their own visibility to drivers and downplay how much more conspicuous clothing could improve safety. In Europe and Japan, some vehicles add lights that turn on when a pedestrian or bicyclist is present.

Adaptive headlights can give both the driver and the outside road users an edge to prevent a collision. Just as Advanced Driver Assistance Systems can use alerts or nudge steering or braking enough to help avoid a crash, adaptive headlights may be able to tipoff drivers and people along the road a few seconds sooner. That fraction of time could possibly be the difference between life and death.



The adaptive headlights Toyota studied do two things to alert people on bikes or walking near the roadway. There's a bright box projected onto the ground around the pedestrian or bicyclist, both to get their attention and to flag their presence for the driver. There's also an icon that shows up in red or white on the ground for the

pedestrian to see. It looks like an upside-down triangle with an exclamation point inside.

Some of the most recent research evaluated which combinations of lights worked best to prevent dangerous behavior. At the start of the study, the research team looked at flashing lights first, then adding the icon. As the work progressed, it became clear doing things sequentially didn't help much.

The research was done at the University of Iowa's National Advanced Driver Simulator, one of the world's best crash simulators. Some trials used drivers, other trials used pedestrians or bicyclists. The Iowa facility has one of only two simulators for pedestrians and bicyclists in the world. Volunteer subjects stand in a darkened room surrounded by video screens that simulate traffic. Researchers recorded how they reacted to different traffic situations.



“The bottom line is the simulator study showed that vehicles equipped with this kind of communicative adaptive headlights are promising and could reduce a large percentage of the pedestrian deaths under the right circumstances,” Sherony said. “Mitigation measures like adaptive headlights could be a building block along with automatic emergency braking to reverse the trend of pedestrian fatalities.”

While there are currently no models equipped with adaptive headlights in the U.S., that could be changing in coming years. The infrastructure legislation passed by Congress last year calls for NHTSA to change regulations to permit high-tech headlights by 2023.

The headlight project feeds into other CSRC research. Other road users have been an area of interest because of the safety potential. A 2020 project looked at how pedestrians and drivers communicate to each other. Research also has begun on how electronic scooters fit into the roadscape.

“Vulnerable road-user crashes are some of the most difficult,” Sherony said. “If you hit a human on the road who is not surrounded by metal, the potential level of injury can be very high even at low speeds. We’re looking at ways we can save more people on the road.”