Self-driving cars must learn the language of cyclists to keep roads safe, research suggests

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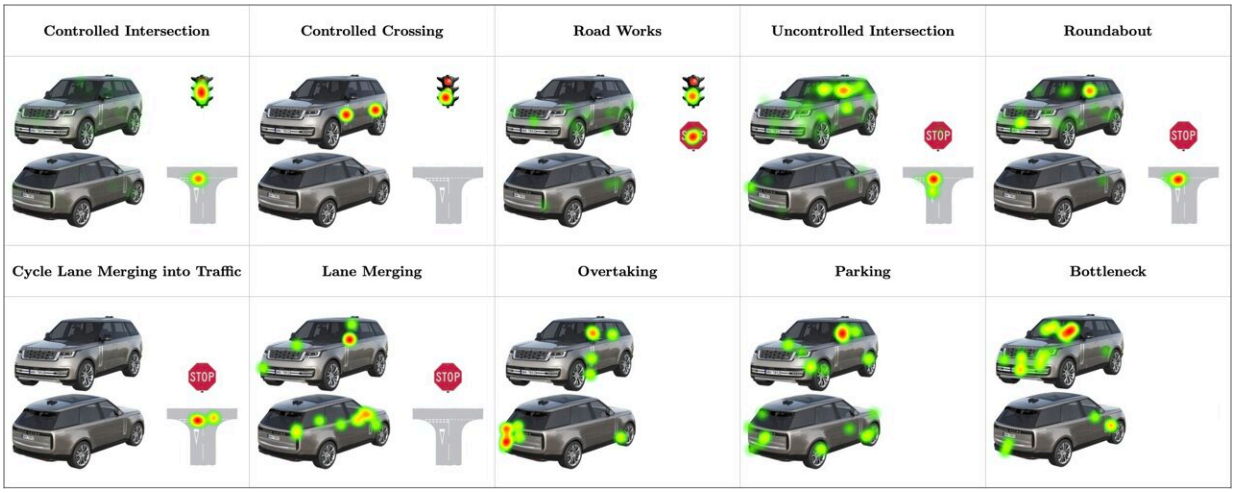


Credit: University of Glasgow

Future generations of self-driving cars should learn the language of cyclists to help them safely share the roads with bikes, new research suggests.

Human-computer interaction specialists from the University of Glasgow are highlighting the need for new systems in autonomous vehicles (AVs) capable of replicating the complex social interactions between human car drivers and cyclists on U.K. roads.

The paper is titled "Keep it Real: Investigating Driver-Cyclist Interaction

in Real-World Traffic," and it will be presented at the ACM Conference on Human Factors in Computing Systems in Germany next week. In it, the team describes how they studied the many ways drivers and cyclists directly and indirectly communicate with each other in real-life situations on the road.

Their findings form the basis of a new series of recommendations on how AVs should behave safely around cyclists in the decades to come, where drivers will be less actively engaged in their journeys. For AVs to work safely in human traffic, they must behave appropriately and understand human communications.

Self-driving cars could better signal their intentions with displays integrated onto their exteriors, the team suggest. A series of traffic-light-like colored LEDs on the cars' edges could to display animations which signal their intentions to maneuver, slow or speed up, or give way, helping cyclists to better interpret the AVs' intentions and respond appropriately.

Cyclists could also wear new types of "smart glasses" that display information on AVs' intentions by allowing the cars to communicate directly with any cyclists around them. AVs could signal that the right of way is up for negotiation, for example, with orange lights displayed on the vehicle and a vibration sent to the cyclists' glasses as a non-verbal message.

Professor Stephen Brewster, of the University of Glasgow's School of Computing Science, led the research. He said, "Cars and bikes share the same spaces on the roads, which can be dangerous—between 2015 and 2020, 84% of fatal bike accidents involved a motor vehicle, and there were more than 11,000 collisions.

"There has been a lot of research in recent years on building safety

features into autonomous vehicles to help keep pedestrians safe, but comparatively little on how AVs can safely share the road with cyclists.

"That's a cause for concern as AVs become more commonplace on the roads. While pedestrians tend to meet AVs in highly controlled situations like road crossings, cyclists ride alongside cars for prolonged periods and rely on two-way interactions with drivers to determine each other's intentions.

"It's a much more complicated set of behaviors, which makes it a big challenge for future generations of AVs to tackle. Currently, self-driving cars currently offer very little direct feedback to cyclists to help them make critically important decisions like whether it's safe to overtake or to switch lanes. Adding any guesswork to the delicate negotiations between car and bike has the potential to make the roads less safe."

The team set out to develop potential solutions to the problem by setting up two observational studies of road traffic in and around the city of Glasgow to learn more about how road users interact.

Firstly, they watched 414 separate interactions between bike riders and motorists at five city intersections during busy periods in the morning and late afternoon.

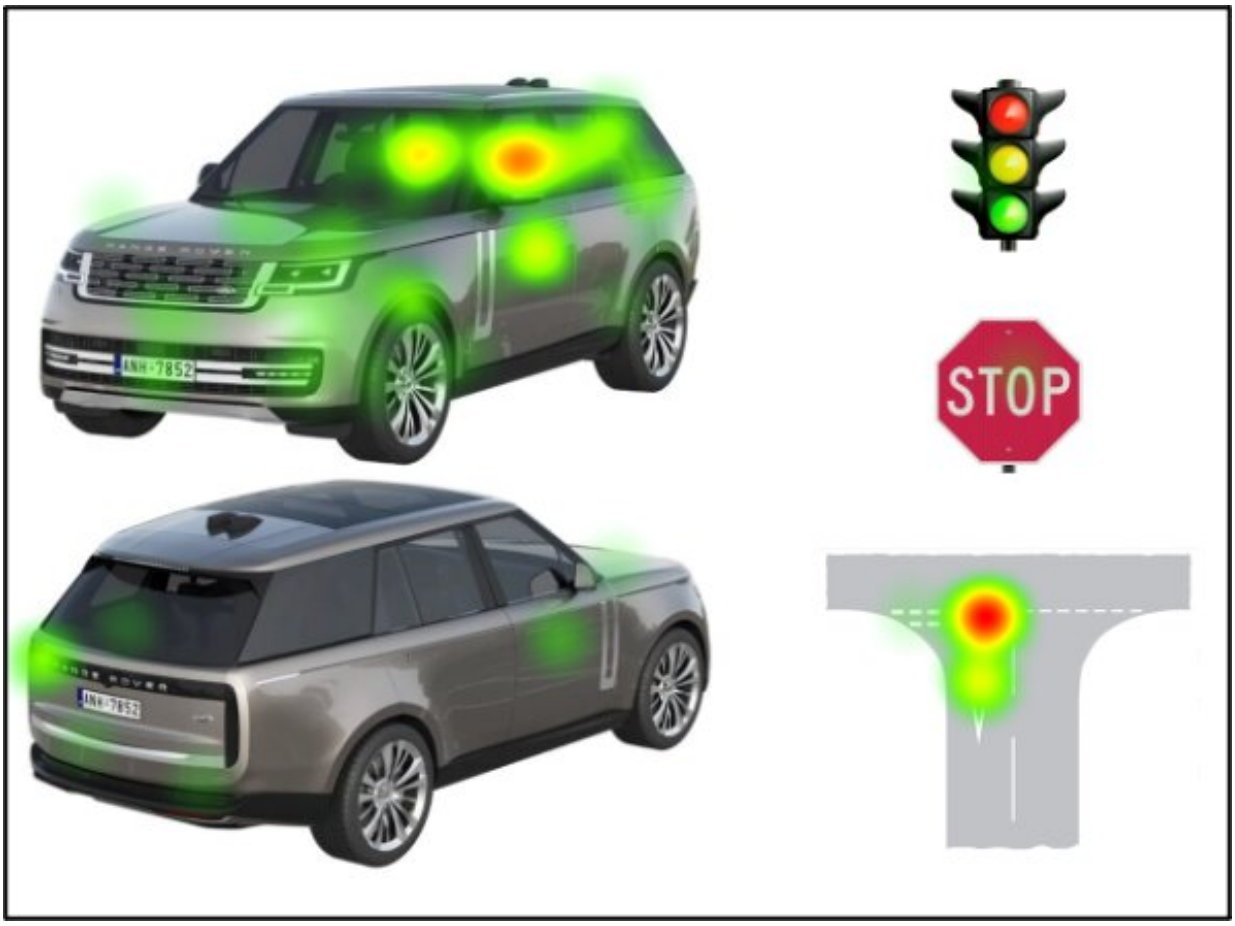
They noted whether the riders and drivers were aware of each other occupying adjacent space, how they indicated their intent for their next maneuver, how they negotiated who would move first, and how they communicated positive or negative feedback once the maneuver was completed.

The observer also took notes on how hand, arm and head movements, facial expressions and vocal cues were used to communicate intention, as well as implicit cues like slowing down or accelerating, and whether car

users used their direction indicators or headlights to communicate.

Next, they equipped 12 volunteer cyclists with eye-tracking glasses and head-mounted video cameras and asked them to bike along their usual commuting route to and from work.

As they traveled, the glasses recorded where the cyclists were looking during their journey, capturing data on their gaze as it touched the road surface, the exteriors and interiors of cars, and road signs and traffic signals. They found that cyclists relied more regularly on information from road signs and traffic signals in situations like controlled intersections. However, they looked at cars much more often to gauge drivers' intentions in situations like roundabouts, uncontrolled junctions and road works.



Credit: University of Glasgow

"Taken together, these two studies showcase details of interactions between drivers and cyclists, and how bike riders use their eyes to make decisions about their movements, which haven't been widely-observed in previous research," Professor Brewster added. "Over time, these road users have developed a shared language which helps them safely negotiate shared spaces in traffic.

"Being able to identify the ways in which that language works will help guide the development of versatile new methods of communication with cyclists that are easily understandable in any traffic situation, reliably

informative, and predictable."

The team identify a number of areas for consideration in future AV designs. Those include guidance that the two-way communication present with human drivers should be maintained, allowing active negotiations through arm movements, which could require the development of more sensitive sensors on cars.

Messages from AVs to cyclists should be timely and visible anywhere around the vehicle, but streamlined enough to avoid overwhelming them with information while they are in motion. The opportunities for positive and negative feedback that regularly occurs between human drivers and cyclists should also be maintained wherever possible, which could also help designers gather data to improve future performance.

Ammar Al-Taie, also of the University of Glasgow's School of Computing Science, is a co-author of the paper. He added, "Just like spoken languages, communication between cyclists and drivers varies from country to country. We're very conscious that this paper focuses specifically on U.K. roads—any future developments will need to take into account the differences in drivers' and cyclists' interactions across the world.

"However, we hope that this research will be a valuable resource for AV designers to consider new ways that self-driving cars can work safely alongside cyclists by speaking their language, wherever they may be."

Provided by University of Glasgow