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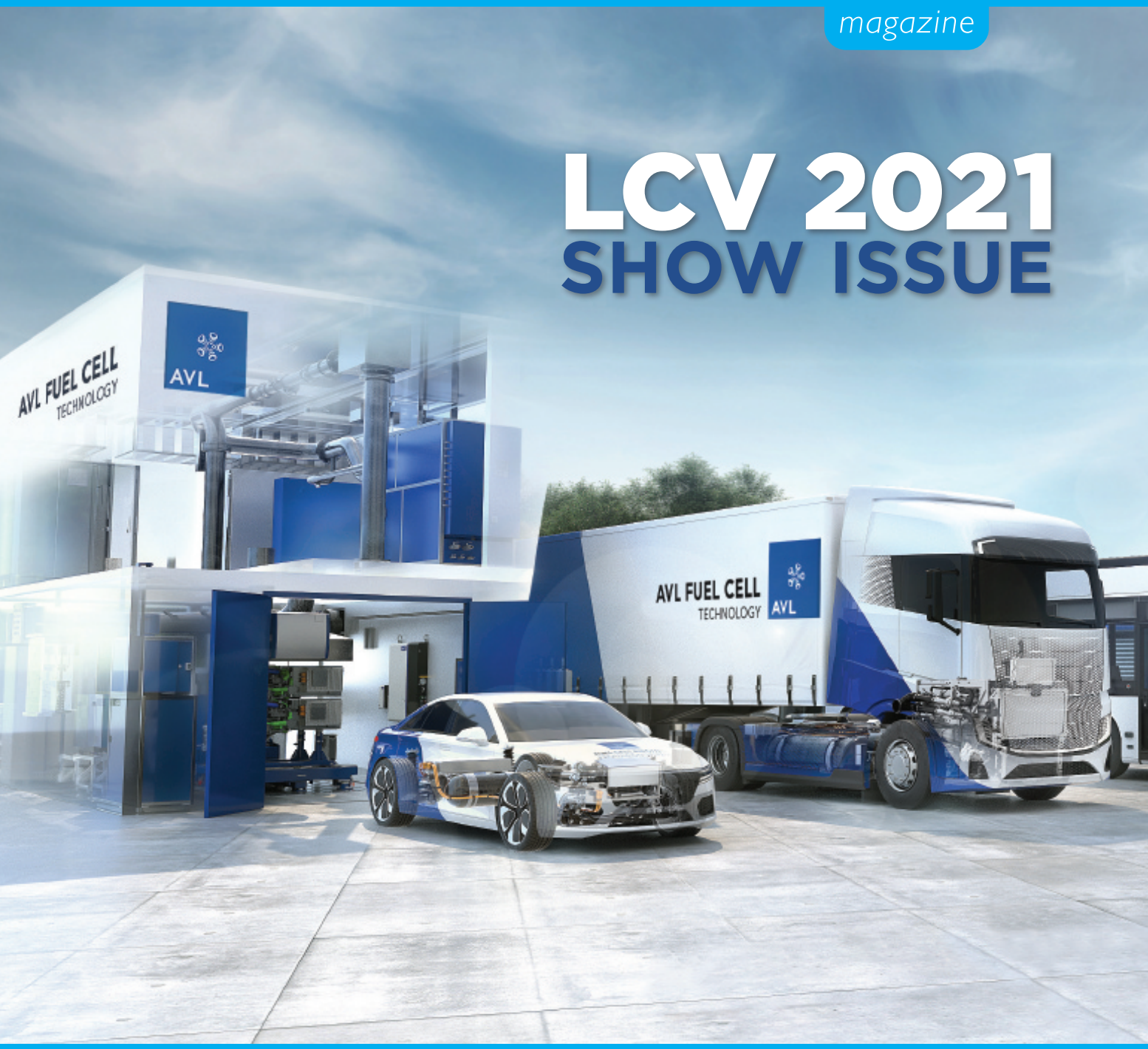

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Safe and sound

Mike Dempsey explains how creating ultra-realistic test scenarios can form the basis of a virtual driving test for autonomous vehicles


Mike Dempsey

What happens if you're driving in your EV down a country road and a family of ducks wanders into view? "A human will take half a second to respond to that situation," says Dempsey. "The autonomous driving systems being developed will process the information in milliseconds. It's much faster than a normal driver."

Take another example of a broken-down car at the side of the road. Should the car break the law and cross double white lines to avoid a crash? A human would know the answer, but a machine won't – unless you tell it. "There are times where it would be safer to allow the vehicle to push the boundaries," says Dempsey. "But it all has to be assessed and become part of your safety case."

Dempsey is MD at Claytex, one of the UK's leading simulation systems providers. Using the rFpro platform, Dempsey and his colleagues create ultra-realistic test scenarios that can form the basis of a virtual driving test for autonomous vehicles.

Claytex is part of D-RISK, a co-innovation project aimed at improving the safety of AVs to make them a commercial reality in the UK and beyond. The project involves four partners: dRISK.ai, DG Cities, Imperial College London and Claytex and is part-funded by the Centre for Connected and Autonomous Vehicles and Innovate UK.

Together, D-RISK project partners are creating a standardised testing approach that will help establish a trusted model for bringing AVs to the roads. Our tests prepare AVs for every possible scenario they might face on the road – including those that have never occurred before. They describe these as "edge cases." Edge cases are those tricky, unplanned and unexpected events that happen while driving – such as a child appearing from behind a car or a plane landing on a motorway.

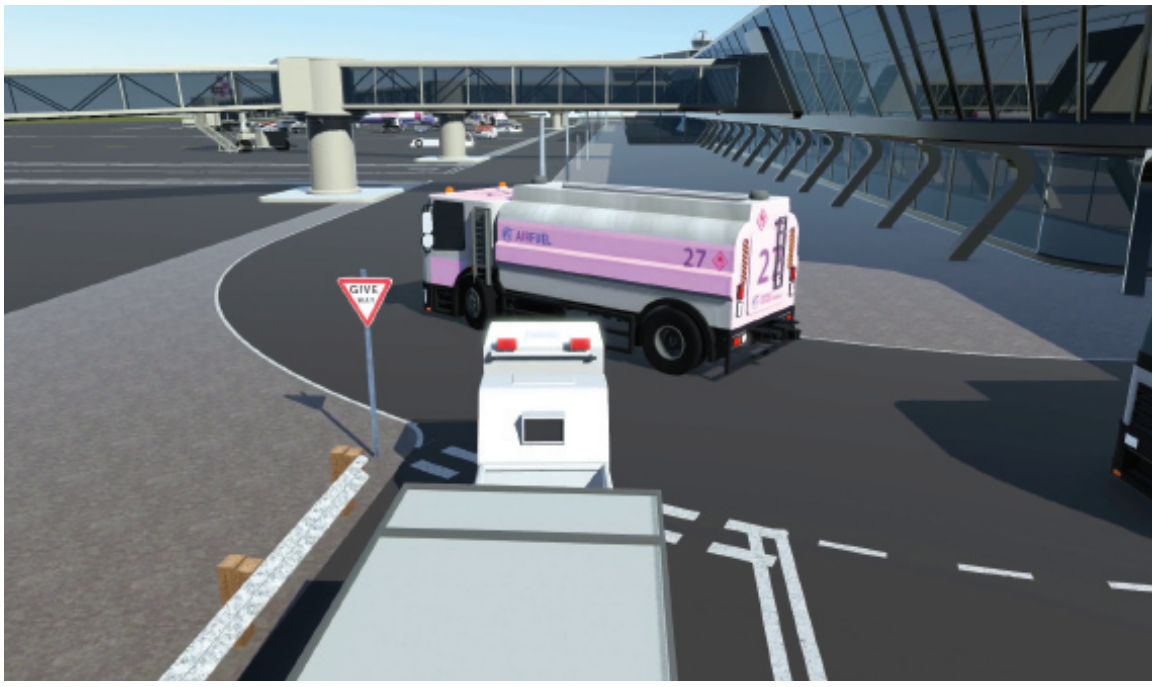
As part of the project, D-RISK partners are collating the edge cases, using various methods, including CCTV data, dashcam footage and crowdsourcing them from the public, and Claytex is building the simulations. It sounds like a lot of fun, but it's fundamental to the success of autonomous vehicles. The systems inside AVs must be able to recognise and react to the situations in a fraction of a second and do so over and over.

When Claytex is supplied with the edge cases, they get to work. "We take that description of how vehicles are going to move in a scenario and recreate that within a simulation with all of the sensor models and everything else that the AI control system needs to know." Claytex uses rFpro to create ultra-realistic renders that appear as genuine as the real world. "The goal through that simulation technology is that the AI controller can't tell the difference between a simulation and the real world," says Dempsey. rFpro demands a massive amount of processing power to run its detailed simulations, the clarity of which is genuinely breathtaking. "It's ultra-realistic," says Dempsey. He describes how they can simulate camera feeds, LIDAR, radar and immerse the AI control system into this virtual world to create an ultra-realistic simulation.

The project started in November 2019 and is scheduled to be completed by March 2022. But the real work of simulation is never-ending, says Dempsey. "There are always new edge cases and scenarios emerging that we will need to model and systems will need to deal with." The rapid emergence of electric scooters is one great example. One of the hardest things to predict is human behaviour, says Dempsey. "We act in totally random and illogical ways that are just not predictable."

While autonomous vehicles hold huge potential, public attention has shifted to the environmentally friendly benefits of EVs. Realistically, will we ever see autonomous vehicles on the roads? "We have to recognise that nothing's ever a hundred per cent safe," says Dempsey. "The goal is that it's at least as safe as a human driver."

Dempsey describes the project's aim as creating a "virtual driving test" for autonomous vehicle systems. "If we're going to let them run around on the roads, we have to go through a process to ensure they're safe," he says. However, Dempsey is cautious about over-promising and believes there's still a long way to go. Simulation provides



SAVAir project - virtual test drive for airside autonomous vehicles

a safe environment to do so, but these systems will still need to perform on the roads, where they will be exposed to edge cases they may never have considered before." Autonomous vehicles will crash," says Dempsey. "We hope that the work we are doing will mean they crash a lot less than cars and vehicles crash today."

While we may need to wait a while before we see autonomous vehicles on the streets, we could very soon be seeing them in our airports. Dempsey describes SAVAir, a Department for Transport funded project to develop a virtual driving test for an airside-autonomous vehicle. "It's a similar concept, but we're focused less on edge cases and more on assessing how safe the vehicle is to operate alongside aircraft." The driving test will require the AV to safely manoeuvre through the dynamic, evolving airport scene to verify that the system is safe to deploy, efficient, and capable of completing the mission effectively. The idea is to de-risk the vehicle, ensuring it's safe to operate around people, passengers and planes. "There are already autonomous baggage tugs in the world," says Dempsey. "People are already looking at how they can implement these things. We're developing the scenarios and the simulation that will give everyone confidence that these things are safe to use."

Dempsey talks passionately about the power and the freedom of simulation, but ultimately, all AV simulation is about setting limits, whether that's speed, distance or personal protection, and assessing how a system responds." There are limits that we have to establish, push and protect," says Dempsey. "We have to put simulations and technology together and push it to the brink of what's possible." As well as pushing limits, systems must realise when they're beyond them and shut down. It's all part of the process of gaining acceptance for AVs, both among the public, industry professionals and legislators.

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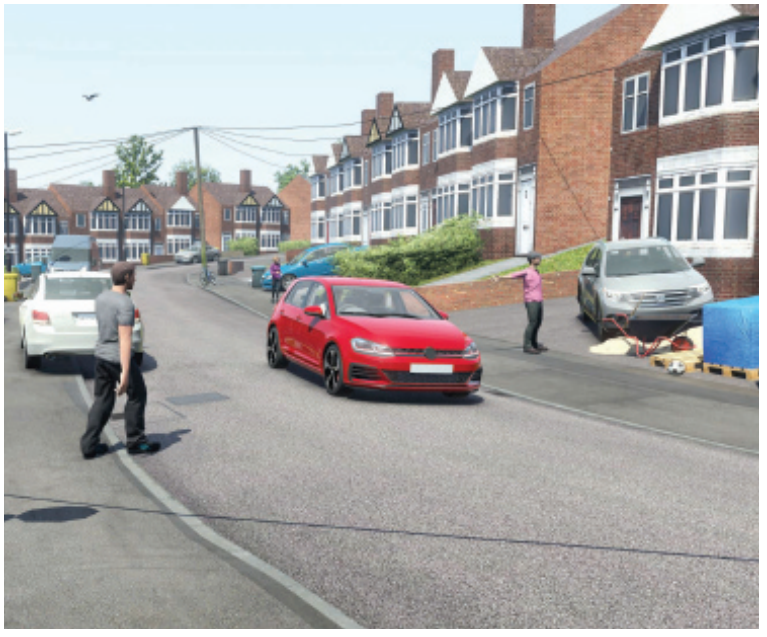


Taking a virtual test drive through residential streets

Making self-driving vehicles safer

The **D-RISK** project is a consortium made up of **dRISK.ai, DG Cities, Claytex** and **Imperial College London**. We spoke to two of these partners to find out more

D-RISK

Listening and learning

Ed Houghton

DG Cities describe themselves as "urban innovators", dedicated to using new technology and data to transform towns and cities.

"We've been engaging the public in exploring the future for autonomous vehicles (AVs)," says Ed Houghton, Head of Research & Service Design at DG Cities. "We want to know how the public thinks and feels about AVs, as well as generating edge cases required for simulation scenarios. "There's a lot of important data that are coded in traditional ways, such as traffic cameras, but we've worked on finding non-traditional sources of information, including crowdsourcing data.

Houghton and colleagues have used Facebook ads to crowdsource edge cases. A simple advert helped to generate massive amounts of conversation on AVs – not all of it positive. "Everyone has a view on autonomous vehicles," he says. "There's something really emotive about AVs." Understanding and collecting information and opinions is critical to identifying barriers", says Houghton. It's not something tech-focused automotive firms are focused on but is crucial to their introduction and adoption.

As well as opinion on AVs, the team have captured 300 real-life road scenarios, he says. To keep things simple, respondents were asked to complete just four questions. "We ask the respondent to describe what the scenario was, who was involved, the vehicles, and what happened." It sounds simple, but the information was rich and detailed, says Houghton. Once completed, the case is compared to the existing library of edge cases. If it's unique, it's included.

As part of the D-RISK consortium, DG Cities is working with a range of partners to create a library of edge cases and hyper-realistic simulations to train AV systems. "We can't put a number on edge cases," says Houghton. "What we're doing is gathering as many responses as we can. We're sorting and sifting as we go." The edge cases are plugged into machine learning algorithms that Houghton, and the wider D-RISK partnership, hope will provide both a learning library for AV systems and an environment for systems testing.

The contribution from DG Cities brings a more human – and critical - element to the hard-tech

expertise of other partners. "We've built a powerful partnership with partners," says Houghton. The D-RISK project has a few months to run, with Houghton and colleagues still actively requesting new data and generating unique edge cases. It's a task that, theoretically, has no end. Houghton and his team have already worked with the public through Project Endeavour, a UK multi-pilot project to test an autonomous vehicle passenger service. "We're always engaging with the public to listen to them and learn from them to embrace the potential for new technology," says Houghton.

www.dgcities.com

On the edge

From road trips to Scotland, traffic cameras in London to jam-cams at a Bangalore roundabout, there's almost nowhere dRISK.ai won't search for edge cases. Identifying the scenarios and codifying them is critical to developing a driving test for AVs, says Chess Stetson, CEO of dRISK.ai. "When a box falls out the back of a truck and disgorges a bunch of electronics on the road, do you stop or keep going?" he asks. "These are the kinds of things that autonomous vehicles have very, very little intuition about and don't do well at."

Chess has been involved in the development of AVs for almost two decades, tracing his history back to the DARPA funded projects in the States. Frustrated at the lack of progress, an Innovate UK bid brought Chess to Britain, where dRISK.ai was created in 2019. Today, the company is part of the D-RISK consortium, working together to develop a new driving test for AVs.

"You don't need to just stimulate better," says Chess. "The most important thing is knowing what to simulate." Asked for an example of what kind of edge cases the team are dealing with, Chess replies. "Can an AV tell the difference between a real chicken and a man in a chicken costume? I can show you in some circumstances that a popular AV can't – and that's a risk." It's these scenarios – and the solution – that Chess pitched to Innovate UK.

"There's still a real bias against using simulated data to train perceptual systems, but there's not enough real data on edge cases," says Chess. The partnership is looking to fill this. Once an edge case is identified, it's codified, validated and processed into a simulation created by Claytex. "I can't say we've got every single thing that's ever gone wrong in the world yet, but we are moving in that direction," says Chess. "The idea is to make a knowledge graph of everything in the real world, the same way Google makes a knowledge graph of the entire internet."

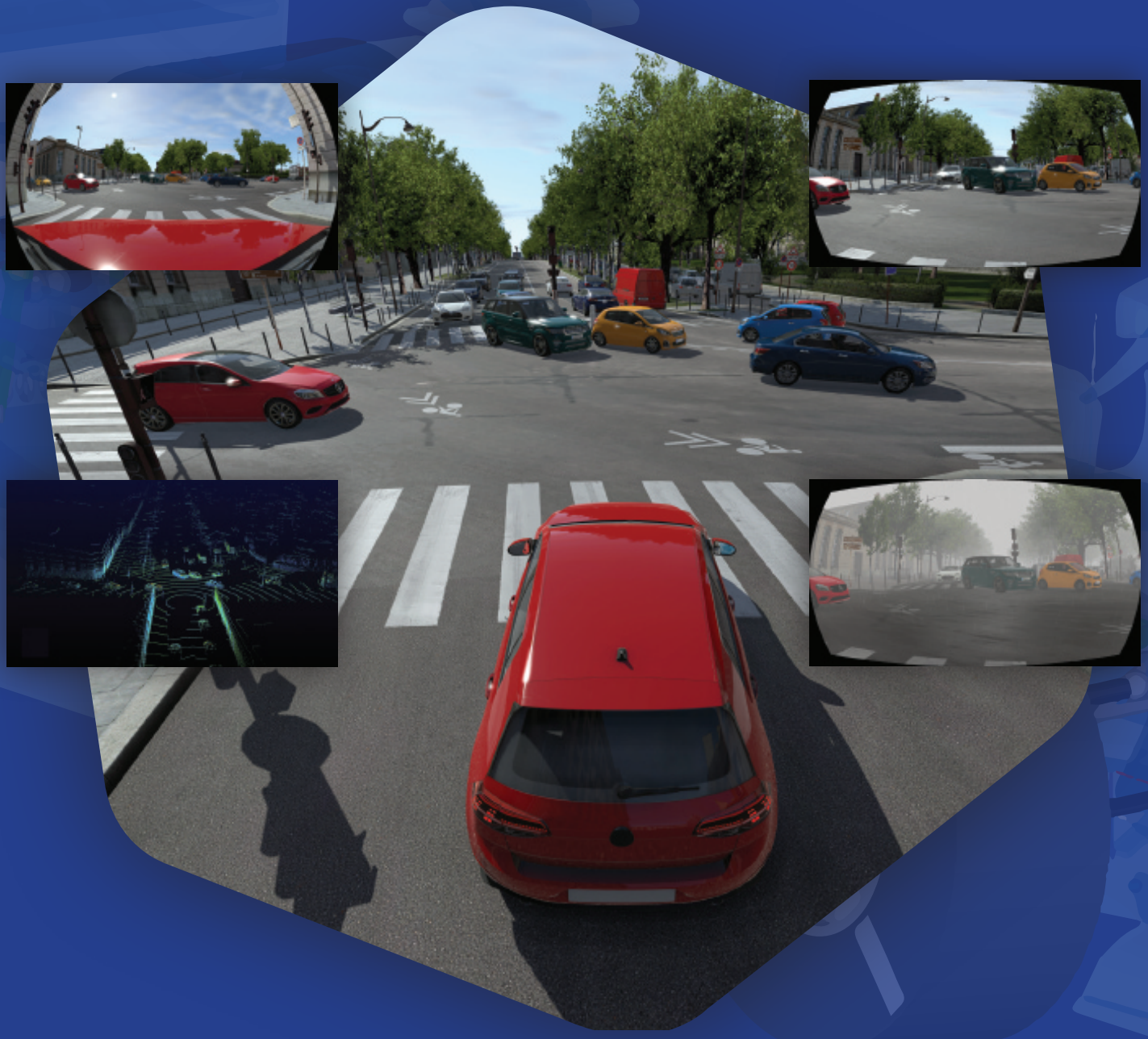
Chess Stetson

The purpose of all this is to develop a driving test for AVs. Edge cases are used to train the system to spot emerging threats and dangers, says Chess. "The right way to test an autonomous vehicle is with different things every time. And they have to be things it hasn't seen before." Faced with an unexpected event – a man in a chicken costume, for example – how will the system know what to do? "We have confidence that the training data we provide will be so good and so extensive and voluminous that the AV could, achieve perfect performance on tests. That is exactly the goal."

Chess describes it as "the ultimate driver's test for self-driving cars" and is supremely confident in its ability to both train and validate AV systems. The D-RISK project runs into 2022, but the search for edge cases will continue with a limitless number of situations and scenarios. Chess and colleagues are engaged in commercialising the technology, with significant interest already in the market. "We have started working with several customers in the AV industry and see the market growing exponentially." The work of Chess, dRISK.ai, and the D-RISK partnership is helping lay the foundations for intelligent and aware autonomous vehicles – just be careful crossing the road in a chicken suit.

www.drisk.ai

Virtual Testing of ADAS and AV



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