

Protecting cyclists

From huge countdown signs at traffic lights to tiny bike-mounted detection devices, technology is helping to make cycling safer, as **Max Glaskin** discovers

This year marks the 200th anniversary of the first true ancestor of the bicycle – the draisine. Invented in 1817, it was the first steerable two-wheel in-line vehicle. No pedals, no chain, it was a grown-up's version of a child's balance bike.

Some 60-odd years later, cyclists were the first to demand that highways should be better than cart tracks, yet today they are among the most vulnerable road users because traffic technology and road design has focused on motorized vehicles.

Now that cycling is recognized as one remedy for urban congestion and pollution, it is attracting a host of clever technical innovations to make it even more appealing.

Riding the green wave

Traffic lights are probably more disliked by cyclists than by drivers. They hate having to stop at red signals because they lose hard-won momentum and have to expend more energy to get moving again when the light shows green. It's one reason cyclists are tempted to jump red



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lights. So there have been several schemes to mimic the green waves that some cities give motor traffic. However, cyclists are not as uniform as motor traffic.

"Realistically, cyclists travel at anything from 10-25km/h [6-15mph], so they spread out and arrive at the next signal over quite a wide period of time," says Robbin Blokpoel, technical research manager at mobility solutions company Dynniq. As part of the European Union's (EU) Horizon 2020 XCYCLE collaborative project, he is leading developments that will help the infrastructure be kinder to human-powered road users.

"We have a special algorithm that stabilizes the signal phases and, next to the traffic signal, a big clock that counts down the time remaining for the green light. It's a meter in diameter so that cyclists can see it from up to 300m [1,000ft] away. They will soon get a sense of whether they can get to the signal while the light is green, or whether they should slow down to arrive in time for the next green phase," says Blokpoel. "In that way, the cyclists create their own green wave."

Car conflicts

It's all very well helping cyclists, but won't the stabilized phases impact the flow of motor vehicles? "We have done simulations, including one of a specific intersection in Groningen, the Netherlands, and the motor traffic doesn't have to make a big sacrifice at all, losing only a few seconds, but still outperforming regular actuated control," says Blokpoel. Public transit will have priority over the green wave and cyclists will be alerted by an additional illuminated graphic on the clock when a bus is on its way.

The system will go live by September at the latest. Meanwhile,



V2X for bicycles

Making bikes part of the connected vehicle network has its own unique challenges, particularly as costs must be kept to a minimum

"We want something that can be useful to the cyclist very quickly, rather than waiting for all the motor vehicle fleet to be equipped with V2X," says Prof. Rajesh Rajamani at the University of Minnesota. "And we wanted something to be inexpensive, US\$200-US\$500. So that ruled out things like lidar for our smart human-centered collision warning system for making cycling safer."

The Roadway Safety Institute at the University of Minnesota seed funded the project and it now has three-year funding from the National Science Foundation. In its current state, bike-mounted sensors detect vehicles approaching from the rear and overtaking.

"It tracks the position of all the cars nearby. If there's a

danger of a collision, an audio warning is provided to the cars – it's an on-bike car horn. With NSF funding, we're looking at a combination of visual and audio," says Rajamani.

An US\$89 laser is used for rear detection, mounted on a movable platform controlled by

a stepper motor. It scans the lane and when the algorithm on a linked microprocessor identifies an approaching car, it locks on to track its position and speed. A US\$20 sonar is used to sense vehicles on the left of the bicycle, in case they make a right hook on a collision course.



A big clock counts down the time remaining for the green light. It's a meter in diameter so cyclists can see it from up to 300m away

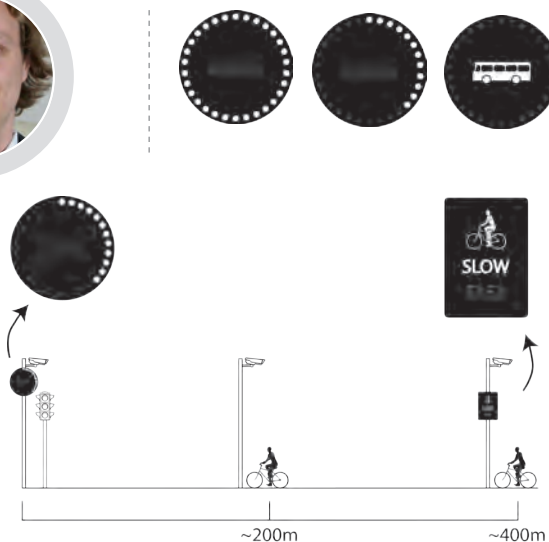
Robbin Blokpoel, technical research manager, Dynniq

the movements and speeds of bicycles and vehicles are being monitored so they can be compared later with results once the green wave technology is in place. A team from Sweden's national research lab, VTI, and the University of Groningen will be using eye-tracking cameras, also, to assess the ways cyclists watch and respond to the clock and signals.

Roadside technology

Another strand of XCYCLE addresses the three persuasive reasons why ITS equipment for cycling will first be part of the infrastructure and roadside furniture rather than on the bike. Bicycles are a relatively cheap mode of transport, so any technology that adds to the rider's costs is less likely to be adopted voluntarily. Also, with only human energy available for propulsion, devices that require more than the lightest power supply will be resisted. Finally, anything added to a bike is exposed to accidental damage, the weather and theft.

So an experimental system for warning truck drivers that cyclists



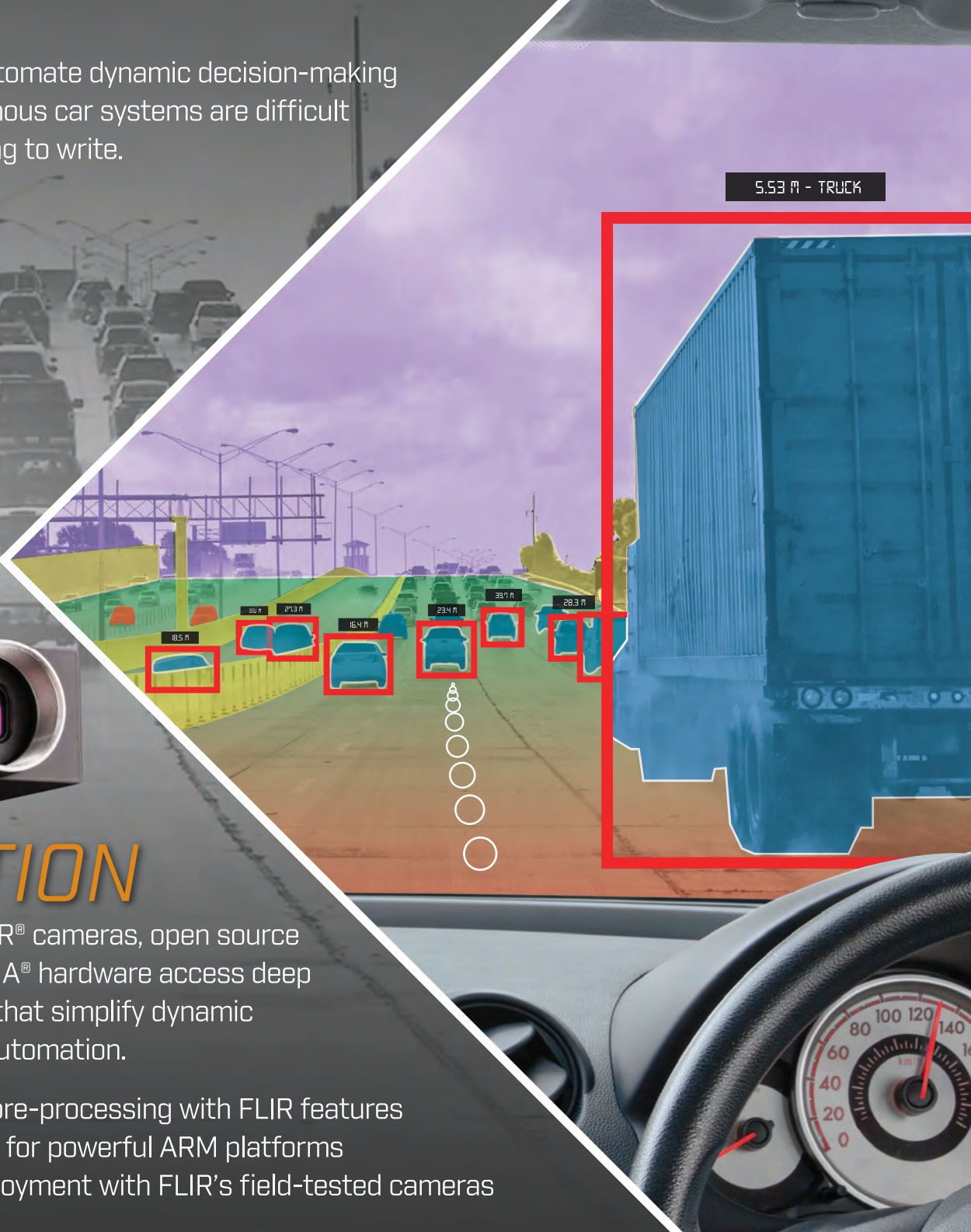
Right: XCYCLE features large countdown clocks at traffic signals to help cyclists ride green waves



PROBLEM SOLVING LESSON #4

PROBLEM

Algorithms that automate dynamic decision-making such as in autonomous car systems are difficult and time-consuming to write.



SOLUTION

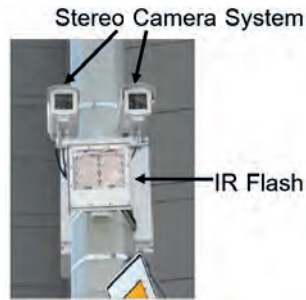
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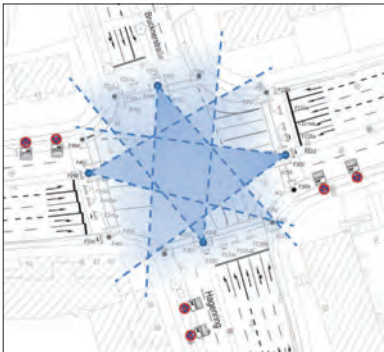
POINT GREY is now





“Data quality is best with stereo cameras... We get the position, speed and trajectory of any bicycle or vehicle, 25 times per second

Kay Gimm, Institute of Transportation Systems, Germany



Above: Testing a system that warns truck drivers of nearby cyclists, at an intersection in Braunschweig, Germany,

are active at an intersection places nothing on the bike or rider, putting all the hardware, software and comms packages beside the road instead. It has been installed at an intersection in Braunschweig, Germany, that is one part of a testbed for intelligent mobility services.

The signal-controlled crossroads have had two pairs of digital traffic cameras added to a suite of existing sensors in order to track cyclists. The cameras work in tandem so that algorithms can create a stereo view. “Experience from a previous project shows that the data quality is best with stereo cameras. The tracking is



much better than with mono camera and radar,” says Kay Gimm, of Germany’s Institute of Transportation Systems. “Infrared lighting enhances their performance in darkness and wet weather to give us 24/7 coverage.”

Multiple servers in a walk-in roadside cabinet analyze the sensor data. “We get the position, speed and trajectory of any bicycle or vehicle from this detection system. That’s 25 measurements every second, in real time,” says Gimm. “Using situation assessment, we can predict their paths and derive whether or not there will be a safety-critical event.” A typical hazard is when a truck turns right, into the path of a bicycle approaching from behind, on its near side.

➡ | Platooning ahead

In the wake of real-world testing of truck platoons, the first technology for bike platoons has been demonstrated

One perceived benefit of bike platoons is that by ‘herding’ cyclists, they’ll help drivers to accept and react to them more easily, safely and efficiently. It may also be simpler for traffic controllers to offer a green wave to a bunch than to a disparate number all moving at different speeds.

The technology for platooning is fixed to the bicycles in three modules and is completely independent of the infrastructure. A control module acquires sensor data, runs the cooperative adaptive cruise control, and operates the other two modules. The low-rate wireless communication module

has a range of 10m (30ft), while location data captured through a smartphone’s GPS is relayed via Bluetooth.

The grips of the handlebar vibrate to tell the cyclists about the platoon leader’s speed, so they can slow down or accelerate appropriately, while keeping their eyes on the road. It has all been put together by engineers at the University of Chile and Icesi University in Colombia.

“We can have up to 10 bicycles in the platoon, each up to 2m (6ft) apart with multi-hop communications for bicycles that are more than 10m from the group leader. The spacing between them should remain roughly fixed during the journey, but the speed will depend highly on the behavior of the group leader,” says Sandra Céspedes from the Department of Electrical Engineering at the University of Chile.



Warning truck drivers

“The idea is that we give out this risk-related warning, through a communication gateway to the truck where an HMI [human-machine interface] is triggered to alert the driver to the bicycle approaching from behind,” says Gimm. “We also plan to have an individually triggered amber light at the intersection, visible to all vehicles, and it will adaptively flash when a safety-critical event for cyclists is predicted.” The system should be functioning fully by next year and includes the possibility of communicating to an on-bike HMI to alert the cyclist, too.

Joining the dots

Making roads safer for cycling is difficult when the information about conflicts is incomplete. In many countries, only collisions with legal, medical or insurance consequences are recorded and even those files can’t be compared because they are not standardized. One European project, called InDeV, may help remedy the problem with a set of technology tools to fill the data gaps consistently. Then road safety practitioners can act on the evidence and reduce the dangers for cyclists.



“We want to compare safety of different intersections, so we are enhancing traffic video data collection and the analysis of collisions and near misses,” says Aliaksei Lareshyn, project coordinator at Lund University, Sweden. Thermal cameras seem to improve collection of traffic behavior at night, which is when more cyclists get injured. The researchers are also assessing the benefits of using two cameras at intersections, so that relatively small objects of interest, such as cyclists, aren’t obscured by larger ones, such as trucks. To marry the images from the two cameras, mathematicians are working on algorithms that recognize the same moving objects from the different perspectives and track them.

Yet even a single camera will collect many more hours of incident-free video than moments of conflict, so InDeV is working to automatically reduce the data to a manageable size and make analysis easier. “We have a tool that automatically edits hundreds of hours of unremarkable traffic video and keeps just the few hours that may contain conflicts,” says Lareshyn. They are also making it robust for long sequences and in all lighting conditions.



“We have a tool that automatically edits hundreds of hours of unremarkable traffic video and keeps the few hours that may contain conflicts

Aliaksei Lareshyn, project coordinator,
Lund University, Sweden



Top: A stunt rider tests an app, which detects when a cyclist has fallen off

App-based collision warning

Hundreds of regular cyclists in four European countries are already contributing data about their conflicts via a smartphone app distributed by InDeV. Put simply, it’s a Q&A form they submit after each incident, but Lareshyn hopes one day it will be semi-automated, triggered by the app recognizing a collision from the data of its accelerometers.

“Stuntmen and dummies with phones in their pockets have been crashing deliberately, to see if there is rotation and acceleration data typical of a cyclist crash,” says Lareshyn. It seems to work for impacts, but not for slow falls and sliding.

A prototype of the app is being used by a handful of volunteers who are able to keep their phone batteries well charged. It’s not being distributed more widely yet because the app needs to monitor movement continuously and it drains the battery within three hours. When phone batteries can last longer, the crash-triggered reporting app will be ready. With luck, it will happen before another 200 years have passed. ○

Max Glaskin is the author of Cycling Science, published by Chicago University Press (USA), Frances Lincoln (UK), and in six other language editions