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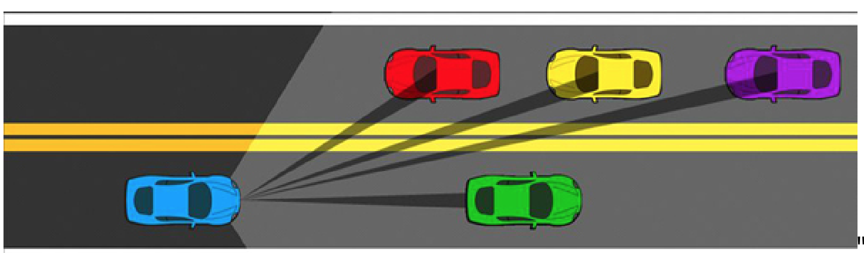
Carnegie Mellon's Smart Headlights Spare the Eyes of Oncoming Drivers

Programmable Lights Prevent Glare, Improve Vision in Snow and Rain

Contact: Byron Spice / 412-268-9068 / bspice@cs.cmu.edu (mailto:bspice@cs.cmu.edu)

PITTSBURGH—A smart headlight developed at Carnegie Mellon University's Robotics Institute (http://www.ri.cmu.edu/) enables drivers to take full advantage of their high beams without fear of blinding oncoming drivers or suffering from the glare that can occur when driving in snow or rain at night.

The programmable headlight senses and tracks virtually any number of oncoming drivers, blacking out only the small parts of the headlight beam that would otherwise shine into their eyes. During snow or rain showers, the headlight improves driver vision by tracking individual flakes and drops in the immediate vicinity of the car and blocking the narrow slivers of headlight beam that would otherwise illuminate the precipitation and reflect back into the driver's eyes.



"Even after 130 years of headlight development, more than half of vehicle crashes and deaths occur at night, despite the fact there is much less traffic then," said Srinivasa Narasimhan, associate professor of robotics. "With our programmable system, however, we can actually make headlights that are even brighter than today's without causing distractions for other drivers on the road."

Robert Tamburo, the project's lead engineer, will present findings from tests of the system in the lab and on the streets of Pittsburgh on Sept. 10 at the European Conference on Computer Vision in Zurich, Switzerland. More information, including a video, is available on the project website. (http://www.cs.cmu.edu/smartheadlight/)

The system devised by Narasimhan, Tamburo and the rest of the research team uses a DLP (Digital Light Processing) projector instead of a standard headlight or cluster of LEDs. This enables the researchers to divide the light into a million tiny beams, each of which can be independently controlled by an onboard computer.


A camera senses oncoming cars, falling precipitation and other objects of interest, such as road signs. The one million light beams can then be adjusted accordingly, some dimmed to spare the eyes of oncoming drivers, while others might be brightened to highlight street signs or the traffic lane. The changes in overall illumination are minor, however, and generally not noticeable by the driver.

System latency — the time between detection by the camera and a corresponding adjustment in the illumination — is between 1 and 2.5 milliseconds, Tamburo said. This near-instantaneous reaction means that in most cases the system doesn't have to employ sophisticated algorithms to predict where an oncoming driver or a flake of snow will be by the time the headlight system responds.

"Our system can keep high beams from blinding oncoming drivers when operating at normal highway speeds," Narasimhan said. Rain and snow present a more difficult problem, he noted; the system reduces glare at low speeds, but becomes less effective as speed increases.

In addition to preventing glare, the projector can be used to highlight the traffic lane — a helpful driving aid when roads have unmarked lanes or edges, or when snow obscures lane markings. When tied to a navigation system, the programmable headlights also can project arrows or other directional signals to visually guide drivers.

"We can do all this and more with the same headlight," Narasimhan said. That's in contrast to new headlight systems that some automakers are installing. These include multi-LED systems that reduce glare to oncoming drivers by darkening some LEDs as well as swiveling headlights that help drivers see down curved roads. "Most of these are one-off systems, however, with different headlights required for different specialized tasks," he added.

The research team assembled their experimental system from off-the-shelf parts and mounted the system atop the hood of a pickup truck, serving as the equivalent of a third headlight during street tests. The team plans to install a smaller version next year in the headlight slot of a truck.

Though currently larger than standard headlights, Narasimhan said the smart headlights could be accommodated by trucks and buses, whose headlights are especially prone to causing glare because they are positioned high off the ground. Eventually, miniaturization should make the smart headlights compatible with smaller vehicles.

The research team includes Takeo Kanade, professor of computer science (http://www.csd.cs.cmu.edu/) and robotics; Anthony Rowe, assistant research professor of electrical and computer engineering (http://www.ece.cmu.edu/) (ECE); Abhishek Chugh, a master's degree student in computer science; Subhagato Dutta and Vinay Palakkode, both master's degree students in ECE; and Eriko Nurvitadhi and Mei Chen of Intel Research.

The research was supported by Ford Motor Co., the Intel Science and Technology Center for Embedded Computing, the Office of Naval Research and the National Science Foundation. It is part of the Technologies for Safe and Efficient Transportation Center, a U.S. Department of Transportation University Transportation Center at Carnegie Mellon.

The Robotics Institute is part of Carnegie Mellon's top-ranked (http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-science-schools/computer-science-rankings) School of Computer Science (http://www.scs.cmu.edu/), which is celebrating its 25th year. Follow the school on Twitter @SCSatCMU (https://twitter.com/SCSatCMU).

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Top Image: The programmable headlight senses and tracks virtually any number of oncoming drivers, blacking out only the small parts of the headlight beam that would otherwise shine into their eyes.

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Carnegie Mellon University News
5000 Forbes Avenue
Pittsburgh, PA 15213
(412) 268-2900