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Adaptive Headlights Could Help Drivers Avoid Hitting Bambi [Video]

Robotics researchers are building a headlight that quickly adjusts to changing conditions, allowing drivers to see through rain and snow, follow GPS directions and dodge roadway obstacles

By Larry Greenemeier | April 24, 2015 | 0

Today's car guts are pretty smart, with dozens of computers that monitor and adjust mechanical and electrical systems on the fly. Headlights, however, are still pretty dumb. Their light sources have evolved from acetylene and oil lamps to tungsten filaments to LEDs in the past century but—outside of advanced headlights available in a handful of luxury vehicles—they simply light whatever is in front of them.

That limitation sometimes causes problems, as indiscriminant illumination reflects light off of snow and rain during storms and creates glare for oncoming drivers, even in dry weather. The so-called adaptive headlights coming to market in select Audis, BMWs, Mercedes and a few other pricey vehicles feature automatic dimmers, motors that reorient the headlights as the vehicle turns or lighting arrays that change beam patterns to avoid shining in other drivers' eyes. Unfortunately even these smart headlight systems typically have only one of these capabilities.

Carnegie Mellon University Robotics Institute researchers are trying to push beyond these boundaries with a programmable headlight that can improve driver visibility by dynamically adjusting to an even wider variety of driving conditions. The team, working out of the institute's Illumination and Imaging Laboratory, is developing a headlight system that avoids illuminating raindrops or snowflakes in poor weather, reducing glare even when high beams are used, lights up the driving lane more brightly than adjacent lanes and provides an early visual warning of obstacles in the roadway.

DEER IN THE (SMART) HEADLIGHTS: A smart headlight system being developed at Carnegie Mellon University's Robotics Institute is designed to provide an early visual warning of obstacles in the roadway.
Courtesy of Carnegie Mellon University's Robotics Institute

Their smart headlight is a looped system that continuously reads, assesses and reacts to driving conditions. A headlight camera senses and captures images in front of the vehicle that are then analyzed by a computer processor. It uses that information to control the headlight's spatial light modulator and divides a single beam from the headlight into one million smaller beams, each of which can be switched on or off as needed.

An earlier version of the Carnegie Mellon system sought to improve visibility in storms by anticipating the movement and velocity of raindrops or snowflakes and shining the headlights into the spaces between them. That proof-of-concept system from 2012 used a digital camera to capture the motion of individual raindrops or snowflakes every eight milliseconds and then applied a computer algorithm to predict where each bit of precipitation will be a few milliseconds later. It then deactivated light beams that would otherwise illuminate the drops or flakes in their predicted positions.

The researchers, led by associate professor Srinivasa Narasimhan, claimed their system reduced the visibility of rain four meters away from the light source by about 70 percent when a car was moving at 30 kilometers per hour. The prototype likewise reduced the visibility of snowflakes, which drop more slowly and tend to be larger than raindrops, by 60 percent.

One version of the system is roughly the size of a small foot locker—about half the size of the original—with a response time of less than 1.5 milliseconds, which is a speed more conducive to highway driving. That system is mounted on the hood of an automobile using suction cups, although the latest prototype is small enough to fit in a truck headlight compartment, says Robert Tamburo, a Robotics Institute project scientist who has helped develop the system since its inception.

The programmable headlight also addresses glare by detecting oncoming vehicles and disabling the light rays directed toward other drivers. This enables the headlight to function on a continuous high-beam setting. Tamburo and his colleagues are working on a way to adjust the headlight to shine on the road ahead based on GPS data, essentially providing a sharply lit pathway that illuminates a particular route, too. The key is increasing the headlight's intensity on the driver's lane so that it is brighter than adjacent lanes. The system's camera can also track and spotlight obstacles—a bounding deer, for example—traveling at up to 80 kilometers per hour crossing up to five meters in front of the headlight.

Such versatile headlights are years away from being widely available on most vehicles but much of this has to do with the investments that car companies are willing to make to develop and implement the underlying technology, says Shree Nayar, director of the Columbia University Fu Foundation School of Engineering and Applied Science's Computer Vision Laboratory. Once the commitment is made to make programmable headlights a reality, he adds, "there's nothing here that poses a fundamental technological hurdle."

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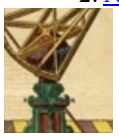
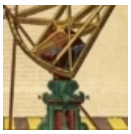

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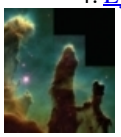
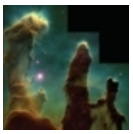

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