An Automatic Visibility Measurement System Based on Video Cameras

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Why This Research is Needed

Traffic managers rely on visibility measures to make safety-related decisions, such as whether or not to close roads or reduce speed limits. However, most existing visibility measurement systems have significant limitations because they are based on the measurement of forward or backward light-scattering effects—only one factor that reduces visibility. Additionally, these systems typically measure a small area only, resulting in reporting errors when local regions of fog, rain, or blowing snow cause visibility to vary drastically from one site to another.

Research Objective

To accurately measure visibility similar to how the human eye perceives it by using a video camera-based system.

Methodology

Kwon developed a new daytime visibility algorithm using fixed targets, a camera, and a digitizer. The system works by aligning the camera to detect contrasting portions of the targets, from which it generates a signal indicative of the contrast levels of those portions. A processor then produces a representative contrast number from the contrast levels detected for each target, and the system generates a nonlinear curve based on both the representative contrast number and the distance of each target from the video detector. From that, a visibility number is produced based on the slope of the nonlinear curve. With additional equipment, including a constant light source in a cylinder-like tube and a light restrictor, the system can also operate successfully in low-light and nighttime conditions.

Targets installed at the visibility study site along I-35 in Duluth, Minnesota.

> *"Since high-speed variability in reduced-visibility conditions is a major cause of crashes, we should have fewer crashes if we tell people to slow down before they're in those conditions."*
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> *—Steve Bahler, deputy director of ITS for the Minnesota Department of Transportation's Office of Advanced Transportation Systems*

Research Results

The research resulted in a technique for more accurately detecting and measuring visibility than previously existed, from which visibility data can be accessed from remote sites through a dial-up modem to the main computer. The system also provides digitized color images for verification purposes.

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What's more, because it uses existing equipment—cameras already installed for traffic control and incident reporting—the system is cost-efficient.

Research Impacts

Visibility is one of the most critical pieces of environmental information for promoting safe traffic operation. This video-based method will aid traffic managers in making decisions and communicating hazardous conditions to drivers before they encounter them, ultimately reducing crashes caused by high-speed variability in reduced-visibility conditions. Additionally, individuals such as highway patrol officers will no longer need to venture out in treacherous conditions to visually gather and report on visibility information.

What's Next

Kwon is continuing to work on refining the video-based process by correcting the image variances caused by multiple compounded factors—such as the type of cameras and digitizers used, lighting conditions, and bit resolutions—through the development of an automated calibration method.

Related Publications / Presentations

Kwon, T.M. and Fleege, E., *Automatic Visibility Measurement Methods Based on Video Cameras,* proceedings of the Xth PIARC International Winter Road Congress, March 1998, Sweden.

Special housing for the cameras protects the image from distortions caused by blowing snow, rain, frost, or fog.