Automated Thermal Imaging Improves Highway Safety

Washington’s Automated Infrared Roadside Screening System Uses Machine Vision to Check Truck Brakes

By: David Lee

Commercial vehicle traffic is at an all-time high on America’s highways, comprising over 30% of all interstate highway vehicle traffic.

Accidents involving commercial trucks number in the hundreds of thousands, and related deaths number in the thousands annually. A significant portion of these truck accidents list faulty brakes as a contributing factor, so brake inspection has become an important part of traffic safety enforcement policies around the country.

To help bolster highway safety, the Federal Motor Carrier Safety Administration (FMCSA) has instituted an effort called the Commercial Vehicle Information Systems and Networks (CVISN), as part of the larger Intelligent Transportation Systems architecture.

CVISN is a collection of information systems and communications networks that support commercial vehicle operations. The Washington State Department of Transportation’s (WSDOT) has instituted its Expanded CVISN program, a vital portion of which is the Automated Infrared Roadside Screening (AIRS) system, due to go into service soon.

AIRS utilizes a FLIR A325 infrared thermography camera enclosed in a protective enclosure mounted in a recessed box in the roadway along the incoming ramp of a commercial vehicle weigh station. The camera provides detailed heat pictures of the undercarriage of commercial vehicles as they enter the station. “AIRS automatically scans and assesses the underside of commercial vehicles for conditions such as malfunctioning brakes, overheated bearings (hubs), and tire risks,” said Victor Bagnall, Expanded CVISN Project Manager.

With the AIRS design, a truck entering a weigh station will pass over the recessed AIRS IR camera before reaching the weigh station building. The camera’s wide-angle lens gives a clear view of the entire underside of a commercial vehicle as it passes overhead. As it crosses the camera at normal speed, the AIRS system starts scanning vehicle’s undercarriage while a digital camera mounted on a pole takes a color image of the truck. The thermal scan continues until the truck has left the camera’s view.

Inoperable brakes, like that shown on the left, are a leading cause of highway traffic accidents. AIRS can detect these and other vehicle-related safety hazards.

AIRS detects inoperable brakes (left) on this commercial vehicle.
Once the vehicle has passed the camera, the AIRS computer analyzes the captured data and looks to see if any of the signal patterns matches the system’s predefined conditions. The computer creates a record of the vehicle, including all of the relevant temperature data and the color image of the vehicle. This record is displayed on the AIRS screen, alongside the records of other vehicles that come into the station before and after it. Records are deleted from the system once the truck leaves the station.

Thermal imaging cameras like the A325 detect and display differences in heat, providing clear, accurate video images based on heat energy called “infrared,” not light as we’re used to seeing with our eyes. These heat images can accurately measure the temperature of millions of separate points each second, and export all of that data to a computer for precise analysis.

Defective brakes are typically colder than a vehicle’s operational brakes, making them clearly visible to the thermal camera. These cold brakes are the primary focus of AIRS at this stage of its development.

“The human eye can’t distinguish between a hot brake or cold brake,” said Bagnall. “In order to detect improperly operating brakes without this infrared technology, the standard method is for someone to physically touch the brake to see if it’s hot or cold, or they have to get lucky enough to actually see that something mechanical on the brake is broken. AIRS allows the user to inspect both sides of every truck that enters the weigh station and still go about their normal work. The only time they need to be bothered is when AIRS gives them an alert.”

Currently, the most common inspection technique is for traffic safety officers to manually check each brake system on each vehicle. This is a time-consuming process, and – because manpower is limited – only a small number of vehicles are inspected at each station.

There are other systems that use thermal imaging to inspect brakes that require an officer to scan each brake visually on a monitor. Again, this is a hands-on task requiring personnel to take an active role in scanning each vehicle, so they’re not widely used.

“I designed AIRS to be hands off and fully automated.” Said Bagnall. “When a truck enters the weigh station and is within view of the IR camera the AIRS system will detect the vehicle, initiate the automated scan as the truck passes overhead, and then analyze the data from the scan. If AIRS finds a problem during the scan it will alert station personnel, and show them which wheel location to inspect and what to look for.”

AIRS is a fully-automated system requiring minimal human interaction. When a problem is detected by the camera and its software, the system will alert the AIRS user of the potential risk based upon predefined analysis criteria. “AIRS is only a tool to help users identify possible risks that might otherwise pass by,” said Bagnall.

Because AIRS can scan and analyze multiple vehicles in quick succession, the computer stores the data so that users can review and display multiple scans at one time.

The machine vision automation software for AIRS is being developed using National Instruments LabView products, and is based on a WSDOT design. AIRS is a standalone software application that will have control of the IR camera, a color camera, and all of the associated systems necessary for AIRS operation.
Vic Bagnall is a contractor currently assisting the WSDOT Commercial Vehicle Services (CVS) staff to develop and implement the AIRS product. Washington currently operates 11 weigh stations equipped with CVISN technology around the state. When fully implemented, AIRS is projected to be installed at these sites.

“I can’t say enough about how helpful FLIR has been in the AIRS development process,” said Bagnall. “They were quick to offer their expertise and act as a sounding board to explore ways to get the most out of their thermal technology in this environment.”

When fully deployed the Automated Infrared Roadside Screening system will give the State of Washington a valuable advantage in the struggle to make highway travel as safe as possible, and automated infrared imaging technology is pivotal to its success.