Oregon Department of Transportation
Research Notes
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Detecting Objects at Railroad Crossings

As the development of high-speed rail in Oregon nears reality (trains moving at 70 mph or more), one of the safety concerns is the danger posed by obstructions on the track. Since high-speed equipment is lighter than traditional equipment, it is more vulnerable to serious damage and derailment by objects on the track.

The highest risks are at intersections with roadways. An object may fall off of a truck or farm vehicle, or someone may drop something. The goal of this research was to evaluate promising technologies for the detection of such objects at railroad-roadway intersections.

Several contributing factors make the detection of objects on a track a difficult problem. The size of objects that must be detected may be quite small, such as a length of pipe or building materials. The environmental conditions vary with time of day and weather. While the detection of potential hazards must be as close to 100% as possible, the number of false detections requiring attention must also be kept to a minimum.

Two detection technologies were selected for lab and field testing – video image processing and frequency modulated continuous wave (FMCW) microwave detection. These two types of technology showed the most promise for detecting smaller objects that might be found at a railroad-roadway crossing. In addition, the two technologies had complementary advantages, enabling them to cover the broadest range of environmental conditions. The specific devices tested were the Traficon "VIP/I - Incident Monitor" video system and the microwave "Remote Traffic Monitoring System" by E.I.S.

There are numerous variables that may affect the sensitivity of the detection equipment, such as weather, lighting, object material, object shape and orientation, object color, entry direction, background color, shadows, distance and angle from detection equipment. The first phase of the research was a laboratory evaluation of each detection device, which focused on a qualitative assessment of several of these factors and quantitative tests of the sensitivity to object size.

Laboratory video detection zone setup

The results of the laboratory tests suggested that both of the systems had sufficient sensitivity for the detection of potentially hazardous objects on railway tracks. Both the video detection unit and the microwave detection unit could consistently detect objects as small as four inches in diameter. Qualitative testing showed that both systems successfully detected variously shaped objects made of wood, metal, and plastic.

Each system had its strengths and weaknesses. The video-based system was capable of high sensitivity, but only if the detection zone size were minimized. Detection was not affected by color, except when the object was the same color as the background. The microwave-based system had high sensitivity over a large area, but the system had limitations in configuring the size and shape of the detection zone for a specific use.

The second phase of the study was field testing. The video system and the microwave system were installed at a railroad crossing on the campus of Oregon State University. The monitoring stations were remotely located, with communication from the detection devices via wireless modem.

View of the field test site from the video camera location

The results of the field tests were quite different from those in the laboratory. The more complex environment encountered in the field reduced the reliability of detection to a point where neither system performed as expected for use in railroad intrusion detection.

The video-based system showed major limitations in its sensitivity to low contrast between the object and the background and also in conditions of bright light and shadows. It also suffered from false positive detections at night due to reflected headlights off the rails as vehicles approached. The microwave detection performance was impaired by the electromagnetically complex environment, registering false positive signals from a swaying crossing gate arm.

Compared to the lab, there was a greater distance in the field between the equipment and the detection area. With the video detection system this distance resulted in decreased sensitivity, i.e., a larger threshold size necessary for objects to be detected. The greater distance may also have contributed to decreased performance of the microwave detection system, as it was unable to detect any target objects placed in the test area, except for a vehicle.

The study concluded that both the video image processing and the FMCW microwave system do have the potential for application in railroad intrusion detection, but that the technologies would need to be developed further in order to function in the railroad crossing environment. The study also recommended that it would be appropriate to reexamine the capabilities of the full range of technologies that exist for intrusion detection, for possible use in rail applications.

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