AASHTO INNOVATION MANAGEMENT

AIM Innovation Showcase Application

Sponsor

Nominations must be submitted by an AASHTO member DOT willing to help promote the innovation. If selected, the sponsoring DOT will be asked to present the innovation at the Innovation Showcase during the AASHTO Spring Meeting.

1. Sponsoring DOT (State): Texas Department of Transportation (TxDOT)

2. Name and Title: Michael Bolin, P.E, Deputy District Engineer

Organization: Texas Department of Transportation

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State: Texas

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Innovation Description (30 points)

The term “innovation” may include processes, products, techniques, procedures, and practices.

3. Name of the innovation:

Using AI to Detect Blocked Railroad Crossings

4. Please describe the innovation.

An artificial intelligence (AI) solution approach was constructed using machine learning (ML) and image recognition to provide a flexible blocked railroad crossing detection and monitoring system. The solution is implementable off railroad right-of-way (ROW) and information is made available to a wide range of users, including emergency services who had no previous insight into a blocked crossing until their arrival. This innovation saves significant and precious response time and results in increased safety and positive outcomes for emergency calls. While the specific current application relates to blocked railroad crossings, the solution can be applied to other scenarios where it is desirable to monitor for blocked infrastructure in urban and rural areas that do not have a fully built-out traffic management system. Click or tap here to enter text.

5. What is the existing baseline practice that the innovation intends to replace/improve?

A pre-emption signal based on the short-circuit of railroad track circuits due to an approaching rail vehicle is the standard mechanism for providing advanced notice of an impending railroad crossing. However, this pre-empt is not always available, can take years to implement with railroad bureaucracy, and is only effective into the traffic signal controller, if one is present. Alternative concepts are necessary to provide a much more robust and wider awareness outside of signalized intersections. Users such as emergency services that depend on non-signalized crossings for critical routes have no awareness of the crossing being blocked until they confront the crossing arm. Additionally, this awareness must be generated outside of railroad right-of-way to minimize interference and time delay in setting it up.

6. What problems associated with the baseline practice does the innovation propose to solve?

(1) Baseline practice only works at signalized intersections. (2) Baseline practice is costly and can take significant time to implement. (3) Baseline practice has no capability to provide alerts outside of the localized signal site.

7. Briefly describe the history of its development.

The project concept was generated after the City of Nolanville, TX, experienced multiple delays in on critical services routes for emergency service calls, due to the presence of a train at an unsignalized intersection. The City reached out to TxDOT, who in conjunction with a research partner, developed , trained, and implemented an artificial intelligence machine learning approach using standard low-cost CCTV cameras located off railroad ROW. Coupled with cellular communications and cloud-based processing, the system provides a robust and flexible approach that can be implemented anywhere a clear line of sight (even angled or on the other side of the grade crossing arm) is available. Power can be solar or utility based on the availability of local resources.
The project initiated with a site review of the two critical crossings identified by Nolanville from provided insight into potential camera positions and power locations. Discussion was also had with the City Emergency Services Departments (EMS) to identify their needs and where and how they wanted to be provided alerts. The first location underwent testing with a portable trailer that could easily be moved to different locations to ascertain the best position for permanent deployments. This trailer also recorded the video which was used to conduct the training set for the ML algorithms. After initial deployment and

extensive testing, the system was deployed at the two critical sites within the City that have a substantial and negative impact of EMS response if blocked. Current status of these intersections along with other information pertaining to the event, such as amount of time the crossing has been blocked, etc., is published in real-time to a web page that is accessible to EMS and the public.

8. What resources—such as technical specifications, training materials, and user guides—have you developed to assist with the deployment effort? If appropriate, please attach or provide weblinks to reports, videos, photographs, diagrams, or other images illustrating the appearance or functionality of the innovation below (if electronic, please provide a separate file). Please list your attachments or weblinks here.

Communication documents were developed that included a single-page PowerPoint™ overview for general concept awareness, a project innovation brief that provided additional details on the key tasks, and a detailed technical report that provided the technical project information.
Attachment 1: PowerPoint™ overview slide
Attachment 2: Innovation Brief
Attachment 3: Nolanville EMS Web Site: http://gradecrossing.tti.tamu.edu/

State of Development (10 points)

Innovations must be successfully deployed in at least one State DOT. The AIM selection process will favor innovations that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.

9. How ready is this innovation for implementation in an operational environment? Please select from the following options. Please describe.

☐ Innovation is fully functional and yet to be piloted.

☐ Innovation has been piloted successfully in an operational environment.

☐ Innovation has been deployed multiple times in an operational environment.

☒ Innovation is ready for full-scale implementation.

This innovation is ready to be deployed at other locations where the same/similar situation exists. Project outreach is underway so that similar needs across the state can be identified and implemented.

10. What additional development is necessary to enable implementation of the innovation for routine use?

None

11. Do you have knowledge of other organizations using, currently developing, or showing interest in this innovation? ☒ Yes ☐ No

If so, please list organization names and contacts.

Organization	Name	Phone	Email
City of San Marcus, TX	Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.
City of West, TX	Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.
Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.	Click or tap here to enter text.

Potential Payoff (30 points)

Payoff is defined as the combination of broad applicability and significant benefit or advantage over baseline practice.

12. Identify the top three benefits your DOT has realized from using this innovation. Describe the type and scale of benefits of using this innovation over baseline practice. Provide additional information, if available, using quantitative metrics, to describe the benefits.

Benefit Types	Please describe:
Improved Safety	Notification of blocked crossings reduce transit time for EMS responders providing critical support.
Organizational Efficiency	EMS is substantially more aware of their full route and any necessary changes prior to leaving their station resulting in faster response times and reducing the time to first aid.
Improved Operation Performance	AI detection of crossing status applies to all intersection types, not just signalized intersections (as opposed to the traditional method of a pre-empt), allowing for a much more robust awareness, reporting, and implementation across

	the entire system to improve both operations of the surface transportation system and the response agencies.

Provide any additional details below:

Click or tap here to enter text.

Deployability (30 points)

The AIM selection process will favor innovations that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.

13. What challenges and/or lessons learned should other organizations be aware of before adopting this innovation?

- Using video as a sensor allows for great flexibility in sensor location away from the railroad.
- The view should minimize objects with similarity to railroad objects (crossings gates, freight cars, locomotives) to avoid false positive detections.
- The background should be evaluated day and night. Harsh lighting from background object is detrimental
- The video camera needs to provide a good view in inclement weather. For example, water droplets on the lens greatly distorts the image.

14. Please provide details of cost, effort, and length of time expended to deploy the innovation in your organization.

Cost: Field equipment approximate cost is $3500 and installation costs will be similar to the cost of deploying a new CCTV camera

Level of Effort: A new CCTV site will need to be deployed in the field. The AI model will need some additions to optimize the detection reliability for the specific site. The additions should take a few days of collection and incorporation.

Time: Overall time from conception through testing and validation was less than 4 months.

15. To what extent might implementation of this innovation require the involvement of third parties, including vendors, contractors, and consultants? If so, please describe. List the type of expertise required for implementation.

The AI model vendor/maintainer will need to add some specific images from the new location to optimize the detection reliability but the effort is minimal.

Blocked Grade Crossing Detection & Alerting using Artificial Intelligence Techniques – Waco: Nolanville (WAC)

CHALLENGE

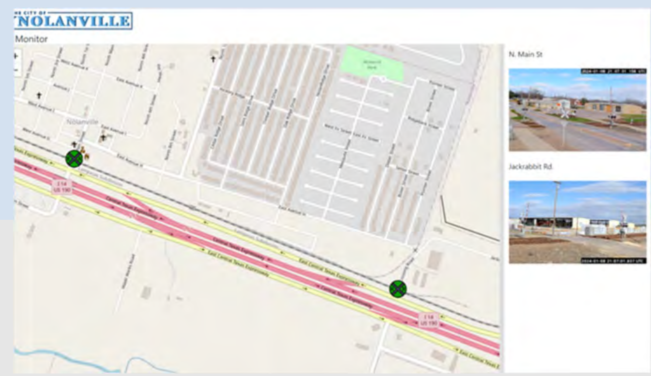
- Grade crossing blockage impacts emergency services and general travel
- No timely and economical detection of blockage if no traffic signal preempts are currently at the site

INNOVATION

- Flexible off railroad right-of-way detection and alerting
- Utilizes emerging AI / machine learning techniques
- Webpage displays real time grade crossing status

BENEFITS

- Low-cost improvement
- Increases emergency services response time reliability
- Provides trip planning information for the community at large



Texas Department of Transportation®

INNOVATION / TECHNOLOGY DEPLOYMENT SUMMARY

Using AI to Detect Blocked Railroad Grade Crossings

CHALLENGE

The city of Nolanville, Texas, a small community west of Belton along Interstate 14, has an ongoing issue with blocked railroad crossings affecting direct roadway access to I-14. Blockages can significantly impact emergency services response times and public travel. The problem is amplified by the fact that few convenient alternatives are available.

SOLUTION

This innovation utilizes cutting-edge artificial intelligence (AI)/machine learning technologies to monitor two important grade crossings in real time. The AI system inputs live camera video of a grade crossing and outputs live crossing status (e.g., crossing open or crossing blocked; see Figure 1). The information is conveyed via a webpage showing a simple map, crossing blockage status, and a current image of the crossing (see Figure 2).

PROACTIVE APPROACH

The AI based innovation delivers economical, real-time grade crossing blockage detection and provides information that can be used by first responders and the public to better plan travel routes. All detection is off railroad right of way, and no Rail coordination is required.

BENEFITS

Although the solution does not remove the trains, the community and the traveling public can use the resource to help plan their travel and find open routes to work, school, and other daily activities. When trains are present, emergency services can use the resource to quickly determine open routes, improving response times.

TxDOT GOALS

- Deliver the right projects
- Focus on the customer
- Foster stewardship
- Optimize system performance
- Preserve our assets
- Promote safety
- Value our employees

INNOVATION / TECHNOLOGY DEPLOYMENT SUMMARY

Using AI to Detect Blocked Railroad Grade Crossings

KEY TASKS

- Identify a partner community with grade crossings where the innovation can be implemented with assistance from TxDOT staff.
- Select a nonproprietary machine vision software model and an appropriate hardware platform that meets specifications for performance, physical size, durability, and power consumption (solar-powered sites are a likelihood).
- Outfit, deploy, and operate a detection trailer to begin gathering important grade crossing data before construction of permanent sites.
- Create a series of improved software models that can be used for training.
- Create a basic website to demonstrate operation of the innovation at selected grade crossings.
- Design and deploy two permanent detection sites at selected grade crossings for long-term operation.

DATA SOURCES

The camera provides all data for the system.

Figure 1. Live blocked grade crossing detection in Nolanville, Texas.

Resources

Waco District (txdot.gov)

Railroad Trespass Detection Using Deep Learning-based Computer Vision (dot.gov)

Artificial Intelligence-Aided Grade Crossing Safety Violation Detection (trb.og)

Operation Lifesaver: Rail Safety Education - Collisions and Casualties by Year (oli.org)

Contact

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Send an email: from our Contact Us page.

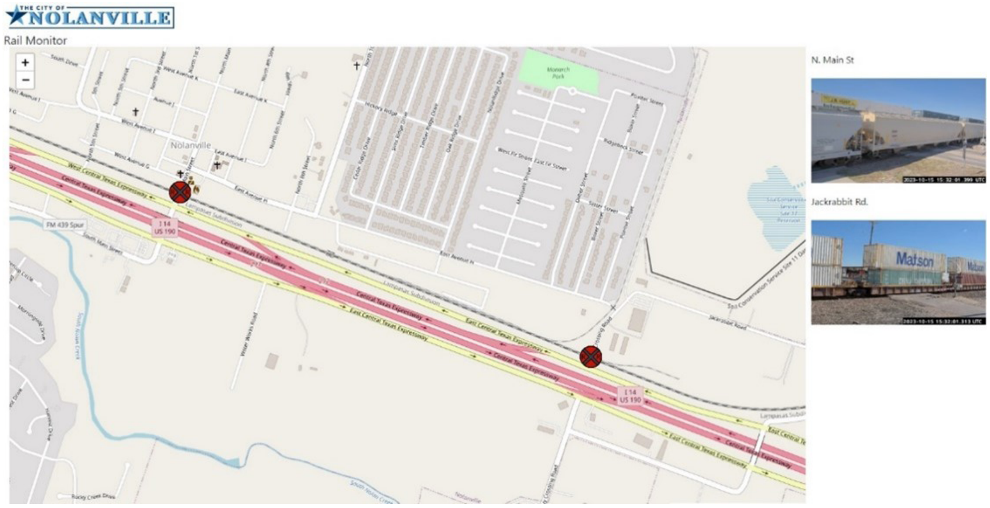

Figure 2. Example crossing monitor webpage.