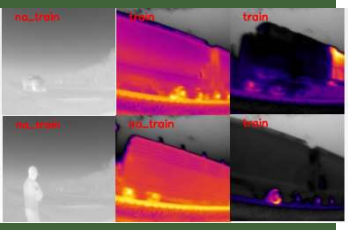
Development of a Low-Power, Low-Cost Rural Railway Intersection Smart Detection and Warning System

Assessing the viability of the heat signature generated from trains as a consistent means of detection from an off the rail and right-of-way (ROW) distance.



Highlight | Dec. 2020

Project No. 19SAUTSA03

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POP: August 2019 – November 2020

This project uses the heat signature of trains as a means of detection to provide preemptive warning for intelligent transportation systems (ITS). Using thermal technology provides a low-cost alternative that is suitable for any grade-crossing location, especially rural areas where power access is limited. The objective of the system is to meet all the standard train detection system objectives at a distance off the rail right-of-way. Two thermal sensors that differ in technology were tested and analyzed to obtain a detection system with the highest efficiency and lowest rate of misclassifications. In addition, a mobile application was developed to provide an updated detection log and further warning for motorists. Field testing was performed at several locations' and accuracy was analyzed as a rate of misclassifications.

Background

In the U.S., there are 129,470 public grade crossings and of those crossings 59,262 consist of a passive warning device. Every year within the last decade, more than 400 rail-related fatalities occur with 28% of these at passive grade crossings. The comprehensive cost per death, is estimated at $10,855,000. That equates to a total loss of $1,215,760,000 at passive crossings each year.

The standard train detection system for the rail industry in the United States are track circuits. These systems are extremely high in cost and power because they require installation within the tracks and access to commercial power, making them unattainable for many rural areas.

Project Summary

The main objective of this study is to explore a new approach for train detection and warning systems to provide motorists preemptive warning at all grade-crossings, urban and rural. The specific objectives are to detect a train's: (i) direction of motion, (ii) stopped motion, (iii) and speed to provide a constant warning time (CWT). These objectives will be accomplished by collecting real time data and training a neural network to detect a train using a network of wireless devices. System accuracy will be evaluated through field testing and determined efficient if the rate of detections are classified correctly higher than 90% while a train is passing.

Status Update

Verification was made that the wheels of a train are always above ambient due to friction of moving parts (Figure 1) and the two sensors used for research were the MLX90640 and FLIR Lepton 3.0.

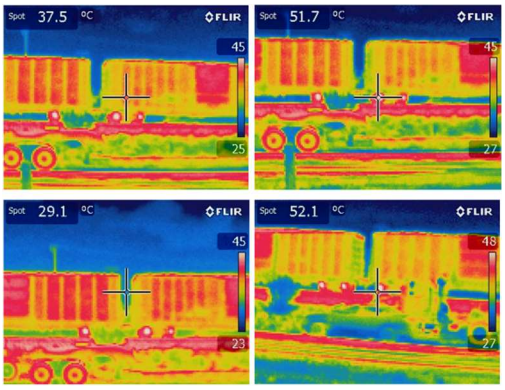

Figure 1. Field demonstration verifying thermal difference between wheels and ambient.

Thermal data was collected for each and a detection model was developed using computer vision coupled with machine learning tools. Simulations were performed in the lab using test data and an accuracy greater than 90% was achieved. Field testing was then executed (Figure 2) and the consistency of correct classifications was determined to be dependent on objects in the field of view (FOV) which were foreign to the training data. Additional data from different locations and weather environments is necessary to further decrease the rate of misclassifications. Local communication amongst devices was achieved using radio frequency and speed calculation was verified using a delay to flash a warning beacon.

Figure 2. Field demonstration of detection accuracy.

Through participation in the National Science Foundation I-Corps program, it was determined that interested parties for train detection reach further than companies within the rail industry. Interviews with 100+ industry leaders in transportation revealed the complications involved with integrating warning systems from grade-crossings intersections and highway intersections. Also, the benefits of reducing traffic congestion by providing a mobile update for preemptive warning was introduced.

Impacts

The main benefits of this study are: (a) exploration of a low cost solution to increase motor vehicle safety at grade-crossings, (b) achieve train detection from off track and rail ROW, (c) reduce amount of false detections caused by weather factors, and (d) expand the viability of train detection to agencies outside of the rail industry. The expected deliverables of this project are: (1) a technical report containing the methodology and performance of the two system developed and (2) showcase the findings of the study in journal publication and at the Tran-SET Conference.

The outcome of this study is expected to be important in setting the direction for computer vision and decision making which will lead to significant cost savings for ITS in the transportation industry. This study will also explore a means of detection from of the rail ROW making preepmtive warning a viable option.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.

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