Improving Rail Safety and Transportation with Real-World AI Applications

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Overview

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- Introducing Wi-Tronix
- AI Primer
- AI Applications in Safety and Transportation
- Crossing Inspection using AI
- Trespasser Hotspot Detection using AI
- Safety Critical Voice Radio Communications Improvements using AI
Who we are

Wi-Tronix, LLC is a leading provider of remote monitoring, video analytics, and predictive diagnostic solutions for high-value mobile assets specializing in rail.

We utilize both edge computing and cloud-based SaaS services to provide real-time data aggregation and analytics to enable operational efficiency.

At Wi-Tronix, it’s simple. We strive to integrate technology to enable businesses to improve the operational efficiency, safety, service reliability, and sustainability of the world’s transportation systems.
Inspired by technology, motivated by safety

- Founded in 2004
  Led by founders
  160+ employees
  Based in suburban Chicago

- 14,000+ rail vehicles
- Platform agnostic monitoring & analytics
- Integrating data on diverse fleets & data sources

- 60+ customers
  4,000+ users
- 4,000+ users across freight, passenger, and light rail markets in the US, Canada, Mexico, and Australia

- Siemens investment
- 2017 investment capital for growth and international outreach

- Innovators at our core
- Leadership team with 100+ years of rail industry expertise
Any significantly advanced technology is indistinguishable from magic.

Arthur C. Clarke
Artificial Intelligence: The Magic

- Artificial intelligence (AI) is intelligence demonstrated by machines, as opposed to the natural intelligence displayed by animals and humans.
- Artificial Neural Networks or Deep Neural Networks are inspired by the biological neural networks of human and animal brains.
- Deep Neural Networks combined with modern sensors create the ability to See, Hear, Feel and Smell.
Typical AI model training loop

Model Not passing performance target.

Sample Results
- Gather and label more sample data
- Model In Production

Deploy
- Validated network

Quality Control
- Performance Improves and Must Pass Success
- Updated neural network

Retrain Network
- Updated training data

Iteration speed is critical to quick learning!
AI-enabled transport applications - rail

- Inspection of vehicle and mobile equipment
- Inspection of infrastructure
  - Track and ballast
  - Crossing gates and light
- Monitor operator performance
  - Mobile Device Detection
  - Alertness Detection
- Determine hazards
  - Near-miss Detection
  - Intruder Detection
  - Passenger Aggression Detection
Obstacles to conquer

• Artificial intelligence is generally probabilistic as opposed to deterministic
  • Many industries have a tradition of “deterministic” safety

• Established regulation is centered around human operations
  • Industry and regulators need to team to shift to performance-based regulation to enable innovative technology such as artificial intelligence

• Human error is more tolerated by society than machine error
  • Litigious environment requires AI based systems to have performance significantly higher than humans
  • Tesla’s objective is performance 10x better than the average human driver
  • Human performance levels may not be well understood
AI-powered crossing inspection

Improving public safety while reducing inspection costs
Reviewing the numbers: National statistics

**US Railroad System**
- 732 Railroads
- 143,804 Route miles of track
- 204,315 At-Grade Railroad Crossings (Public, Private, and Pedestrian)

**Nationwide Public At-Grade Crossings**
- Active 56% (with gates, bells, and/or flashing lights)
- Passive 44% (with signs/markings, but not active warning devices)

9 People or vehicles are hit by a train daily

96% Of rail-related fatalities over past 10 years are due to railroad grade crossing and trespassing incidents

The problem

- Fatalities at grade crossings and from trespasser incidents are increasing over last 5 years – not declining as desired
- Successful development & deployment of trespassing solutions also remains flat
  - Limited pockets of success
  - Sustainability has not been achieved

➢ Need a new approach with today’s technology to solve this!
The solution:

Majority of rail vehicles have forward facing cameras

99.99% of captured camera imagery gets thrown away...

How can we use it for improving public safety?

➢ Detect exceptions and take action!

Utilize onboard cameras with AI to identify and improve grade crossing and trespasser problems
AI-powered crossing verification: What can be automated?

Goals:

• Gate arm status [CFR 234.223, CFR 234.255]
• Mast and Cantilever light flasher status [CFR 234.217, CFR 234.253]
• Detect gate arm misalignment [CFR 234.223, CFR 234.255]
• Warning system activation verification [CFR 234.225, 234.257]
• Commercial power availability verification

Front-facing imagery + AI to verify crossing

Outcome: Automated Crossing Verification
Assessing warning times
Additional visibility to crossing objects via long range cameras

Standard outward camera:  

Long range camera:

➢ Start activation: 20 seconds before
➢ Gates down: 5 sec before train arrives
Wi-Tronix rail crossing assist

An innovative, AI-based vehicle platform approach for remote monitoring of crossings

- Lower lifecycle cost: Platform approach allows for continuous innovation to solves for multiple problems today and in the future
- Enhanced safety and **30% faster** response to gate arm malfunction reports
- Reduced investment: **No sensors at crossing**
- **Reduce operational** cost by using AI and on-demand video to confirm proper operation of the crossing
AI-powered trespasser detection
Front-end AI-enabled cameras will guide future decisions related to infrastructure, and safety education and enforcement

Grant: $1,648,000  |  Awarded to Brightline and Wi-Tronix by the Consolidated Rail Infrastructure and Safety Improvements (CRISI) program

- **Step 1:** Install HD forward-facing cameras throughout Brightline’s fleet (21 locomotives)
- **Step 2:** Capture video data to develop/train AI model
- **Step 3:** Identify unsafe behaviors on Brightline’s corridor; Brightline to identify areas in need for additional community outreach, law enforcement presence, or engineering projects
Trespasser hotspot detection

What:
• Solution that utilizes artificial intelligence (AI) to **collect trespasser hotspots** and trespasser behavior

Benefits:
• Focus investments on **high-risk areas**
• Enables railroads to perform **targeted public awareness** and educational campaigns
• Enables law enforcement personnel to perform **efficient policing** of public safety actions
East Palestine, Ohio
February 3, 2023
Introducing RAIL Radio View

Safety critical voice radio communications improvements using AI
Defining the problem

- Limited visibility on crew compliance with radio announcements for reporting emergencies to dispatch
- Lack of visibility into whether dispatchers promptly attend to emergency calls
- When no message is received from the defect detector, or if the message is unclear or not understandable, the crew is required to immediately reduce speed/stop and contact the train dispatcher
- No visibility to determine whether the crew is following the above rule, leading to potential safety concerns
- Failure to properly protect shoving movements can be fatal
- Railroads have limited to no visibility to crew radio communication during shoving movement

➢ How do we provide visibility to radio communication?
➢ How do others address this?
RAIL Radio View

One-click audio transcription access adding another level to your immersive experience

✓ Record cab audio and transcription in the event recorder
✓ See transcriptions on the timeline in Violet View (online event recorder player)
✓ View closed captions on inward camera view
✓ Search key words from the last 48 hours
Enable in-depth incident and low-cost operational testing verification of critical communication in the following scenarios:
C.S.X. Equipment defect detector. Milepost 1.0.1 Track 2

CSX Equipment Defect Detector Milepost 1.0.1 Track 2. No defect. No defects total axle six eight ten of transmission
Audio to AI Transcription example

*The Audio clip you’re about to hear was recorded from the unit installed in the field with Violet.

that second motor, see what's going on with it if it's clean or if it's got a traction motor cut out. All right, I'll give it a look as soon as we get up there. All right. Dispatcher asked you about that DEP. It shows it's dead, but I guess you told him it was running. It shows running. It's showing loading right now. Good enough. Southbound look good? Yeah, cold hoppers look good. You'll have a good evening. Thank you, too.

*Please note: transcription above is transcribed by AI
Audio to AI Transcription of Train to yard master example

*The Audio clip you’re about to hear was recorded from the unit installed in the field with Violet.

I agree, just a fly. I'll do it for you. Greg, you want this light number? You can give it to me. 05406. 05406. Alright. 231, north.

*Please note: transcription above is transcribed by AI
Inward camera view with closed captions
Window can be pinned to the right for easy viewing of data and AI-powered transcriptions.
Selecting a time in the transcription window will take you to that point on the timeline.
What else can we do with transcriptions from radio?

- **What if AI could** process the transcriptions to **understand** what was said (or not said) in the dialog?
- **What if AI can automatically** process this dialog to **detect exceptions**?

Potential AI Automated alerts from transcriptions:

- Proper radio communication around Emergency rail incidents
- Proper response to defect detector events
- Proper radio communication during shoving movements
Rail Safety can be transformed with real world AI-powered solutions!

AI is not magic. A robust training program is required. Just as human education can be costly, AI training can also be costly.

Clear system performance criteria is required to properly implement and deploy AI enabled solutions.

AI is a tool that can improve rail safety in areas that were previously considered unsolvable.

AI is an element of an overall solutions and solutions always need to be outcome focused.
thank you

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